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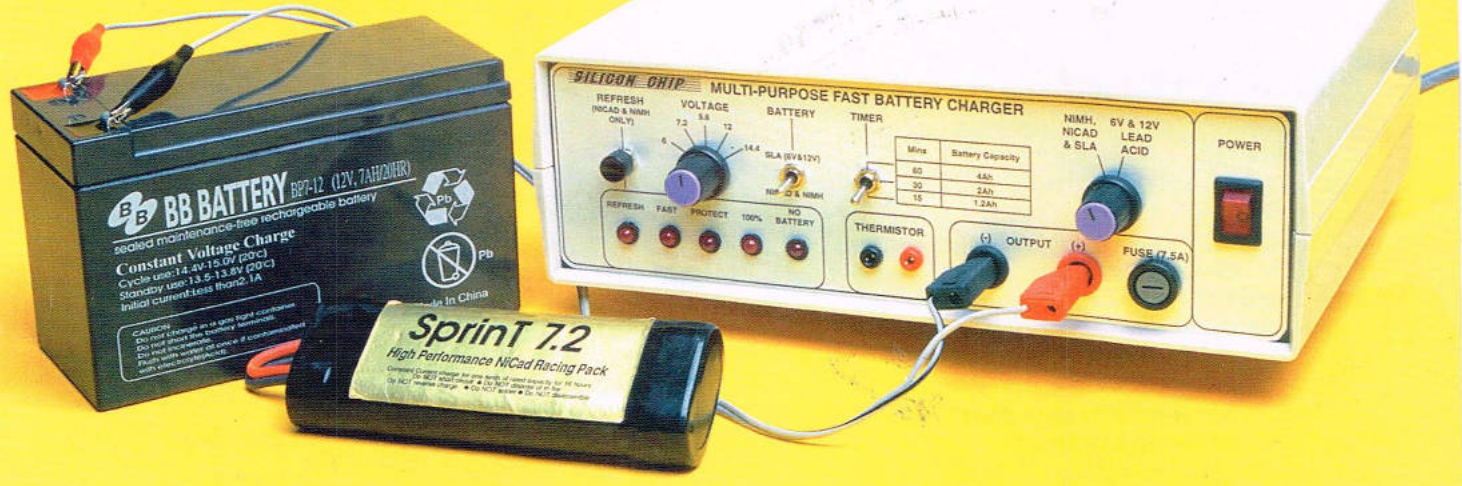

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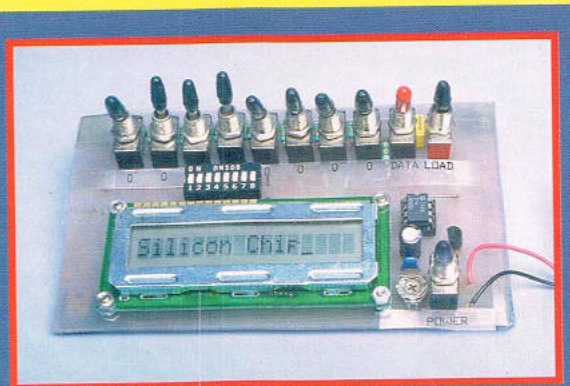

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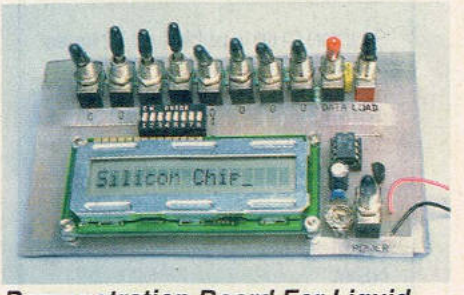

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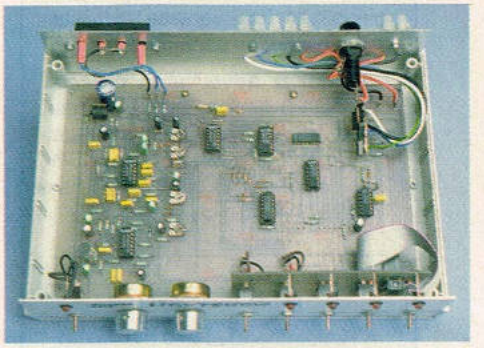

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PUBLISHER'S LETTER

Deflation has been with us for a long time

Anyone who has tried to follow the news of Asia and Australia's currency decline in the last few months must be confused. And worried! After all, some notable economists are now using the dreaded "D" word; D stands for deflation. It seems that inflation is no longer a worry and deflation is to be feared. Apparently, a little inflation is good for all of us but deflation could be really bad.

Well, I have to say it. Most of these economists are talking rubbish. They just don't know what is going to happen, any more than the ordinary person in the street. But I can also state that deflation has been around for a long time and we have been living with it very happily and we expect it to happen in the future! How can I say that?

Deflation is defined as "an abnormal decline in the level of commodity prices, especially one that is not accompanied by an equal reduction in the costs of production". This is exactly the deflation that some economists are worried about. As Asian countries struggle to export their way out of trouble, they will supposedly flood Western markets with cheap goods and so Western economies will suffer. Well, hasn't Asia been doing this all along?

Over the last 40 years or so, we have seen the prices of virtually all manufactured goods plummet in real terms and this applies especially to electronic equipment of every description. The price drops have been brought about because of the two relentless forces of increasing competition and the march of technology. There is no reason to suppose that this will not continue at an ever increasing rate, regardless of what happens in Asia. At the same time, we can expect the prices that Australia obtains for its commodities (minerals, wool, wheat, etc) to decline as well. Nothing new here.

As an aside, the fact that Asia is in trouble now indicates that the calls for Australia to get heavily into "high technology" manufacturing would have been to no avail. Asia has done just that and look where it is. Yes, yes, I know that I am ignoring such things as defective Asian banking systems, corruption, artificially low interest rates, etc. All these are peripheral issues. The real reason that Asia is in trouble is that it has excessive production capacity for virtually everything and all those high-tech factories eventually have to be paid for.

However, there has to be some silver lining to all the dark clouds, hasn't there? If the economists are correct and Asia is to export its way out of trouble, it has to buy raw materials from somewhere and that is most likely to be Australia. So why is our currency on the decline?

The point is that no-one really knows. The most common phrase you hear in economic news is "market sentiment" and that means that not much logic is being brought to bear.

My tip, and it is as good as anyone else's, is that Australia's currency will rebound. Perhaps it will do so even before this issue hits the news stands. But whatever happens, you can bet on electronic equipment continuing to get cheaper in real terms. So will most other mass-produced commodities. Everything else is in the lap of the gods.

Leo Simpson

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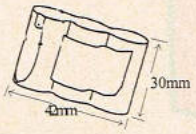

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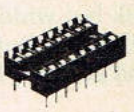

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Surplus Mania

Hot web sites for hard-to-get bits & pieces

By ADRIAN CUESTA

If you love searching out obscure parts at the cheapest prices, try buying surplus and distress stock components! You'll find lots of goodies at various web sites on the Internet.

One of the best things about being interested in electronics and other technologies is finding the bargains – those bits and pieces that others see as junk but which to you open up a whole new world of possibilities. But besides haunting garage sales and secondhand stores, where else can you find the good gear?

The are lots of companies specialising in the good bits, both in Australia and overseas. And while buying from overseas used to be difficult, that's no longer the case. What's more, you can easily browse the catalogs of the overseas companies via the Internet. Most of the o/s companies also have printed catalogs available that can be sent to you for quite reasonable sums.

In no particular order, here are the best surplus companies that I've found on the Internet:

(1) Vorlac Industries & Rockby Electronics

If you don't know about these guys, boy are you ever missing out! Both businesses are at the same location and have the same contact numbers, but Vorlac specialises more in discrete electronic components while Rockby has larger bits and pieces.

A couple of things make these companies stand out from the crowd: they're right here in Australia, they have a good range, and they are CHEAP, CHEAP, CHEAP! OK, so that's three things.

Once you are on their mailing list, they send out a specials flyer every couple of months. In it are components such as PROMs, op amps, power transistors, diodes, capacitors, resistors and the like. The stock changes each time and it's all brand new, original packaged stuff.

But what I like is the range of weird and wonderful parts that pop up – odd-sized cable ties, square rubber equipment feet, crocodile-clip test jumper leads, magnetic card readers, a laser diode module and so on.

Postage costs $7 for up to 3kg ($5.50 within Victoria). The easiest way to reduce that is to pitch in with some mates and put everyone's order under the one address. I've been buying from these companies for 12 months and everything has been as good as they state. It's the only

place where you can spend $30 or so and get a box of genuinely exciting stuff home-delivered to your door. Very highly recommended.

Address: 261 Huntingdale Rd, Huntingdale, Vic, 3166.
Phone: (03) 9562 8559 Fax: (03) 9562 8772
Internet: http://www.rocom.com.au; http://www.vorlac.com.au

(2) Surplus Sales of Nebraska

Doesn't that name just roll off the tongue? And their catalog just about rolls the postman's bike to a standstill! Costing $US10 delivered by airmail to Australia, their 400-page catalog is well worth the money. It lists an enormous range of electrical and electronic components but it's not your everyday 1990s type stuff. No sir; if you're over 50 and/or you like vintage radio, this one's for you!

There are literally hundreds of valves, huge RF variable capacitors (some 38cm long!), RF coils wound from 10-gauge silver-plated wire, and rotary ceramic switches capable of handling 15kV and 30 amps. In the range of power supplies there are ancient units capable of supplying (from the US 115 volts AC mains) 0-36 volts DC and 50-300 volts DC. And there are vibrators working from either 6V or 27.5V DC.

There are also strange meters, such as a 0-50A DC Westinghouse "nuclear meter" and an 87mm meter that is calibrated 0-180 seconds with a full scale deflection of 30V DC. There are solenoids and connectors, relays and robots – a vast array of the weird and wonderful. The stock leans towards brand new equipment from the last 50 years but has a sprinkling of late-model equipment.

Thirteen pages are devoted to Collins communications equipment parts and accessories. As far as I can determine, these parts are not generally available from other sources. The prices seem to me to be on the high side but if you're after a brand new, never-used Collins 20-pole lever switch from an ancient receiver, $US25 may well seem cheap.

Address: 1502 Jones Street, Omaha, Nebraska, 68102, USA.
Phone: 0011 1 402 346 4750 Fax: 0011 1 402 346 2939
Internet: www.surplusales.com

(3) Surplus Traders

This company has a huge catalog available on the Internet but, unlike other companies, generally has parts available only in bulk quantities. Three million comic books at three cents each is one deal that I remember well!

From this example, you can see that it's not just electronic components that this company sells. And thankfully, you don't have to buy in such huge quantities! Often you need buy only 10 units, a number which can be quite achievable – especially if you have a few mates interested in the same sort of things that you are.

The parts that pop up are incredibly varied – from Bosch automotive relays for a GM car (13,000 available at $US1.50 each in lots of 500) to a single used Blood Gas Analyser in good condition for $US1500. And there's almost everything in between!

Discovering whether or not Surplus Traders have (or will have) what you want is eased by a number of factors:
(1) they have an inbuilt search engine at their web site;
(2) the site is very well organised and indexed; and
(3) you can add your e-mail address to an "interest list".

Doing the latter means that you will be automatically e-mailed details on the products that become available in those categories. And don't worry that you will drown in e-mail – I added myself to more than 20 different categories and receive notification of 5-10 new products about once a fortnight.

The prices vary enormously, being cheapest for bulk specials. In fact, some of these are real eye-openers. Even with the price in US dollars, sometimes the money being asked is something like one-quarter of local retail. Me? – I'm waiting for some EFI injectors or automotive MAP sensors to come up. I'll buy 500 of them and make a killing!

Address: PO Box 276, Alburg, VT, 05440, USA
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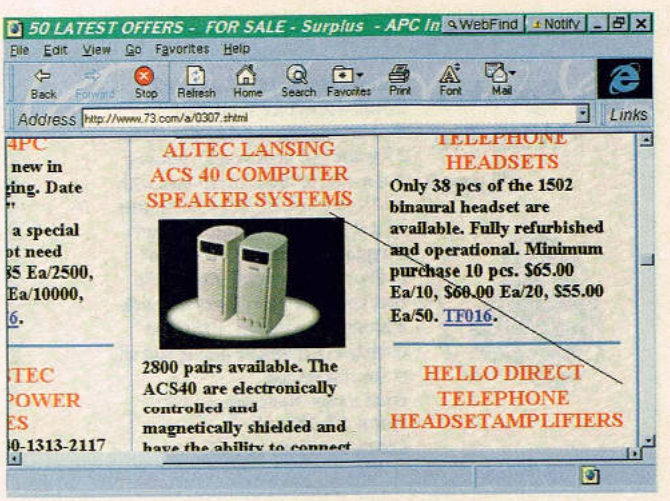
Internet: http://www.73.com/a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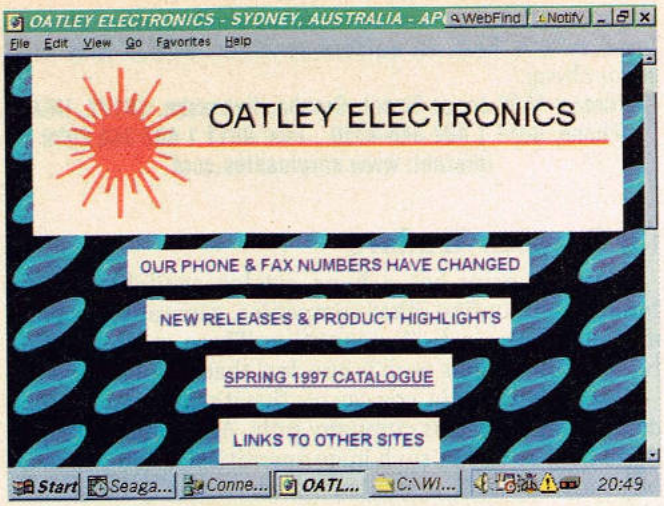
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NEW RELEASES & PRODUCT HIGHLIGHTS
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(4) Oatley Electronics

If you read their ads in this magazine, then you already have a pretty good idea of what Oatley Electronics sell. The real benefit of checking out their web site is that they also have a "Bargain Corner" where they list lots of components and products that are available only in small quantities – too small to advertise in the magazine.

At the time of writing, "Bargain Corner" bits and pieces included 50 used 4.7nF 3kV ceramic disc capacitors for $9, 10 mini dynamic 8-ohm loudspeakers for $2, replacement fridge thermostats for $8 each, and 10 TAA611B audio amplifier 1 watt ICs for $15.

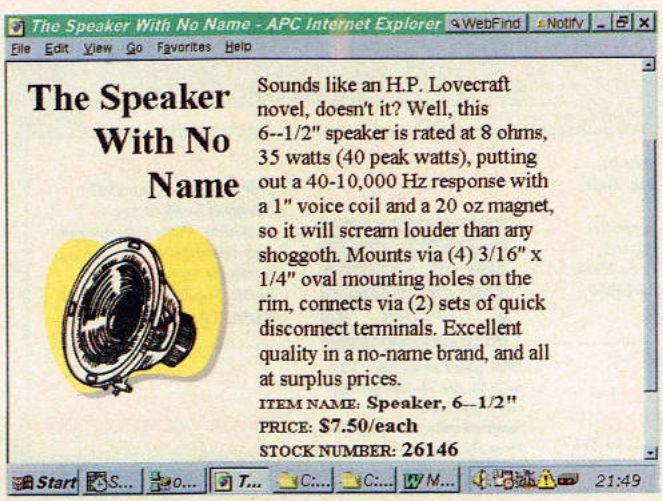
As you can see, the prices are very competitive!

Address: PO Box 89, Oatley, NSW 2223.
Phone: 02 9584 3563
Fax: 02 9584 3561
Internet: http://www.ozemail.com.au/~oatley

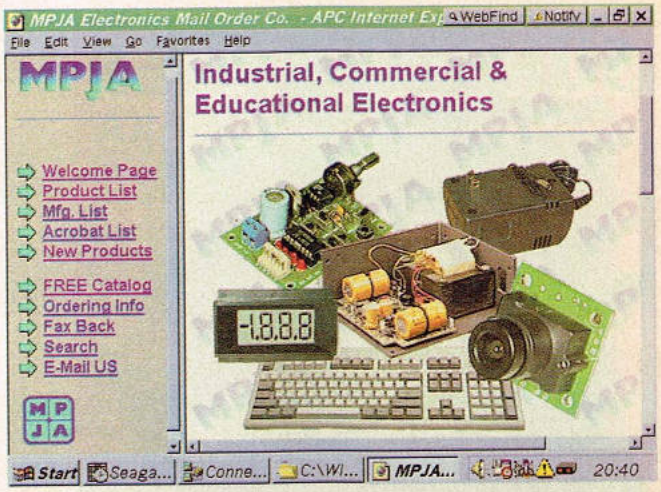
(5) American Science & Surplus

This company is the ideal place to look if you're a school science teacher – or doting grandparent. While there are quite a few surplus products like fans, motors and other products (not too many components, though), the real strength of this company lies in their wide collection of weird and wonderful toys and experiments that are mostly science-based. Prices seem quite good and the collection varies from feeder kits for squirrels to Peltier heat pumps.

Address: 3605 W. Howard St, Skokie, IL, 60076, USA.
Phone: 0011 1 847 982 0874 Fax: 0011 1 800 934 0722
Internet: http://www.sciplus.com


The Speaker With No Name - APC Internet Explorer
File Edit View Go Favorites Help
The Speaker With No Name
Sounds like an H.P. Lovecraft novel, doesn't it? Well, this 6--1/2" speaker is rated at 8 ohms, 35 watts (40 peak watts), putting out a 40-10,000 Hz response with a 1" voice coil and a 20 oz magnet, so it will scream louder than any shoggoth. Mounts via (4) 3/16" x 1/4" oval mounting holes on the rim, connects via (2) sets of quick disconnect terminals. Excellent quality in a no-name brand, and all at surplus prices.
ITEM NAME: Speaker, 6--1/2"
PRICE: $7.50/each
STOCK NUMBER: 26146
Start
21:49

(6) Marlin P. Jones & Associates Inc

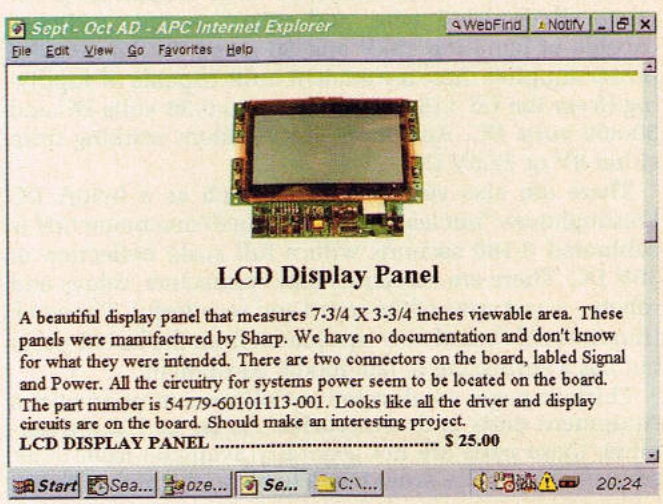


This company has a very well presented Web site with a wide range of kits, components and equipment. The kits range from computer trainer/programmer items through to audio gear, alarms, games and sound generators. The company is very much like one of the larger Australian electronic stores in the range and prices. MPJA will probably have a full catalog on-line by the time you read this and should then be worth a close look.

Phone: 0011 1 561 848 8236 Fax: 0011 1 561 844 8764
Internet: http://www.mpja.com

(7) Gateway Electronics, Inc

Gateway are well worth checking out. You'll find video cameras and monitors, Peltier junction coolers, LCD display panels, lights, microphones, motion detectors and other such products. The subheadings on their contents page include amateur radio and small motors.


Sept - Oct AD - APC Internet Explorer
File Edit View Go Favorites Help
LCD Display Panel
A beautiful display panel that measures 7-3/4 X 3-3/4 inches viewable area. These panels were manufactured by Sharp. We have no documentation and don't know for what they were intended. There are two connectors on the board, labled Signal and Power. All the circuitry for systems power seem to be located on the board. The part number is 54779-60101113-001. Looks like all the driver and display circuits are on the board. Should make an interesting project.
LCD DISPLAY PANEL ..... $ 25.00
Start
20:24

They also have a section devoted to speciality multi-pin connectors – those dedicated multi-pin connectors that you find on car audio, CBs and ham equipment. They're often impossible to get through normal avenues but Gateway has a wide range available. Prices are good.

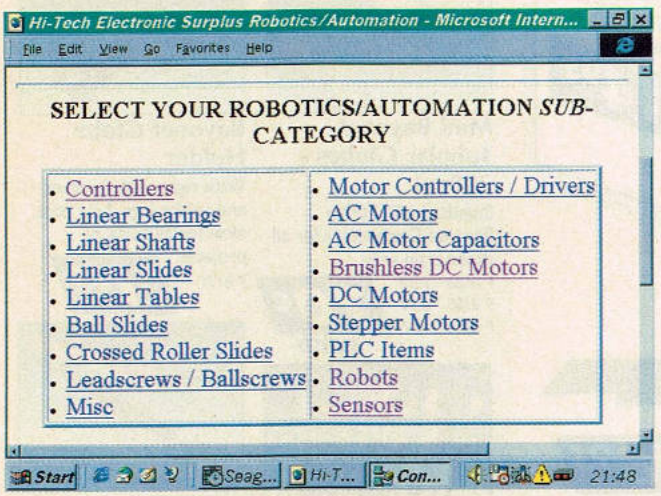
Address: 8123 Page Blvd, St Louis, MO 63130.
Phone: 0011 1 314 427 6116 Fax: 0011 1 314 427 3147
Internet: http://gatewayelex.com

(8) Hi-Tech Surplus

This company has very few single parts listed. Instead, they specialise in assemblies and sub-assemblies.

For my money, the best products are the electro-mechanical interfaces. Anyone trying to get an electronic circuit or a computer to actually do something in the real world needs input sensors and output actuators. After all, how do you get your robot to do anything if there aren't any motors, arms or bellcranks available?

In the robotics/automation category, Hi-Tech Surplus list the following sub-headings: (1) Controllers; (2) Linear Equipment; (3) Miscellaneous; (4) Motors; (5) PLC Items; (6) Robots; and (7) Sensors.



Typical of Hi-Tech Surplus's products is a robot arm that has about 12mm of vertical movement, continuous rotation and a weight of 7.5kg. It costs $US55 in used form. Under the Controllers category, there are temperature, pressure and flow controllers. An example is a "Blue M Electric STAT 1900" temperature controller that uses J, K or T thermocouples, has a 4-digit display and a time proportioning PID with an SSR (solid-state relay?) driver. It's new and costs $40.

There is also a wide range of other subject headings (audio, video, manufacturing, RF, test equipment, power supplies and others) that lead you to the sub-category that you're interested in.

A good range of motors and associated equipment is also listed, including: AC Motors; AC Motor Capacitors; Brushless DC Motors; DC Motors; Motor Controllers/Drivers; and Stepper Motors. The prices seem to be quite reasonable.

Address: 605 East 44th Street, Boise, Idaho, 83714, USA.
Phone: 0011 1 208 375 7516; Fax: 0011 1 208 375 6571
Internet: http://hitechsurplus.com

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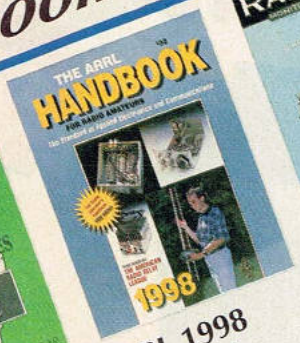

ARRL 1998 Handbook

75th Edition - 1,200 Pages

Bumper 75th edition is bigger and better than before with updates and loads of new information. Includes URL details so design and information software can be easily downloaded off the Internet for PC and Mac users.

B 2234 **Still only $54.95**

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Covers specific radio frequencies used by Australian railway authorities. It also contains information on VHF and UHF railway radio, government usage, private mining company railway plus industrial and tourist railway networks. It's a must-have for all radio scanning hobbyists and model railway enthusiasts.

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For experiments, model trains etc. Similar to our popular mini pilot globes but in 3V! Green leads for 3V identification.

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Fast blow fuses. IEC127 Certified for safety.

630mA @ 250V P 8401
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Mini Bayonet Tubular Globes - 300mA

Standard MBC (Mini Bayonet Connector) for all those train sets!

P 8183 1.5V
P 8185 6.3V
P 8176 12V

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With right angle bracket and solder lugs. Low cost, ideal for all sorts of projects.

P 8171 **$1.35**

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$8.95

Cut those wires with precision! Has a handy hacksaw too! T 3605

Plastic Instrument Case

Sturdy black case is ideal for a model railway switching set-up, or any other project for that matter! Size:88mm(W) x 128mm(L) x 43mm(H). H 2502

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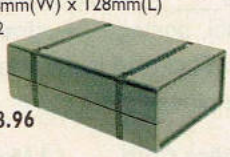


Modeller's Mini Coloured Globes - 1.5V 3mm

Ideal for toys, model railways, decorations etc. Has a coloured glass lens and is ideal for projects requiring incandescent lights instead of LEDs. Black wire for "hiding" the lead.

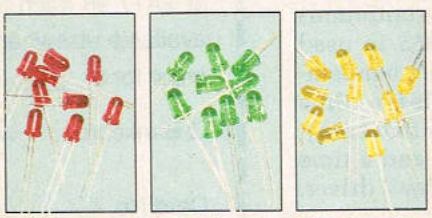
Red lens	P 8120
Green lens	P 8121
Blue lens	P 8122
Yellow lens	P 8123
Orange Lens	P 8124

70¢ each

Solderless Test Probes

Low cost replacement for multimeter leads has a lock-ring for wire entry.

Red P 1754
Black P 1755 **$1.25**



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- Accepts a range of standard cable types with RCA, 6.5mm phono and Cannon connectors and works with cables with any combination of these plugs and in practically any length.
- Power source required: 9V DC battery.
- Supplied with all components, PCB, plastic case and pre-punched and screened front panel.

K 7231

$39.95

HOT PRICE!

EA Feb '98

Battery Controller for dual 12 volt batteries

- Automatically switches your auxiliary battery into the main electrical system for charging once the engine is started.
- Disengages your main battery when the engine is stopped.
- Switches between primary and auxiliary battery automatically.
- Supplied with all components, hardware, PCB, diecast box and front panel label.

K 3212

$34.50

SAVE $10

Silicon Chip Jan '96

Speed Controller

- Use with routers, jigsaws, circular saws etc.
- Control from fully stopped to maximum speed.
- Uses modern switch mode power supply techniques, not traditional phase control methods.
- Can power up to 2400W series motors.
- Rating of up to 10A @ 240V.
- Motor's speed is relatively constant under load.
- Excellent very low speed operation.
- Freedom from cogging (irregular bursts of speed).
- Overcurrent limiting and fuse protection.
- Constructed in safe, earthed diecast case.
- Interference suppression included.
- Adjustable speed regulation.
- Power source required: 240V AC.
- Supplied with all components, PCB, pre-punched diecast case and screened front panel.

K 3087

$119

EA Nov '97

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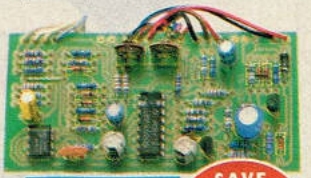
Wave Form Generator

- Frequency Range: 10Hz to 100KHz.
- Both amplitude and frequency are voltage controlled.
- Combine two of these to make an audio sweep generator.
- On board voltage regulation to ensure good stability.
- Power source required: 9V battery or any DC supply between 8.5 and 15V.
- Supplied with components, PCB and hardware such as potentiometers and switches.
- Case optional (use H 2851).
- PCB size: 43mm x 87mm.

K 2802



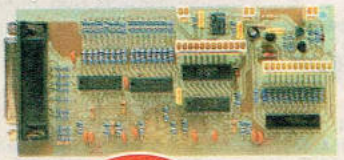
$19.35

SAVE $2.15

Parallel Port Interface Kit

- Able to sense and process data, using the results to control relays, motors, solenoids etc.
- Can monitor 10 analogue voltages and drive 8 digital outputs.
- Generates 2 variable voltages.
- Includes simple programs that can be manipulated to suit your needs.
- Power source required: 9V battery or 9V DC supply.
- Supplied with components, PCB and 25 pin "D" type connector.
- Case optional (use H 2851).
- PCB size: 68mm x 145mm.

K 2805



$38.25

SAVE $4.25

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- Great for applications where interference-free data is required.
- Microphone and auxiliary input.
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- Power source required: 9V battery.
- Supplied with components, PCB, mic insert, 4 metres of fibre optic cable and a pair of transmitter and receiver devices.
- Case optional (use H 2855).
- PCB size: 23mm x 78mm.

K 2803

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Availability: Our kits consist of many different parts from numerous suppliers. Whilst we have consulted closely with them and are satisfied as to their ability to supply, sometimes problems can arise in obtaining all of the parts. This means there is a slight chance that availability may be delayed. Rainchecks are available, however if you'd like to check beforehand, please don't hesitate to contact your local store.

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Great price, won't blow your budget!

W 3180

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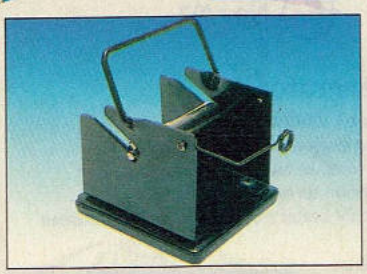
Butane Pencil Blow Torch

Great for heatshrink work, silver solder, gold, silver, brazing or glass work. Fits easily in your pocket - but switch it off first!

T 1380

$9.95



Solder Roll Holder/Dispenser NEW

Strong metal holder makes your soldering life easier!

T 1295

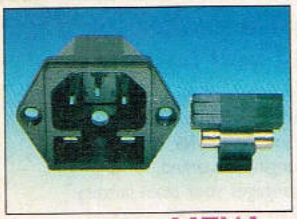
$16.95

$5 DISCOUNT

off a 200g roll of solder! When you purchase the Solder Holder.

Limit 1 roll per customer.

(Applies to N 1619, N 1621, N 1623, N 1628)



IEC Male Chassis Connector NEW

10A with fuse holder. Measures 5 x 20mm.

M 7068

$4.95

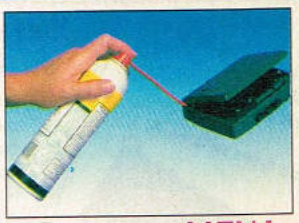
13 piece Precision Knife Set

Comes with 3 quality knife handles in various sizes plus 10 spare blades in a variety of shapes and sizes. Includes handy plastic storage case. Replacement blades available.

T 3618

SAVE $5

$9.95



Dick Smith Lubricant Spray NEW

Improves motor generator winding insulation resistance, protects against high humidity, improves electrical properties, displaces moisture, loosens corroded nuts, bolts etc. 300g can. Non flammable.

N 1196

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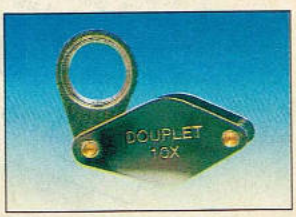

Pocket Magnifier

Ideal for checking surface mount components, cracks in PCB tracks or the quality of solder joints. This well-made magnifier with 15mm lens provides 10x magnification and slides back into its plated brass case when not in use.

T 4595

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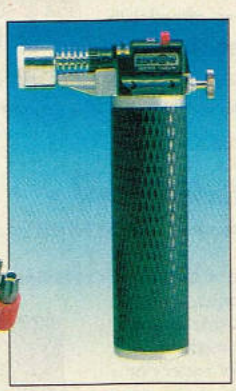
T 4506

$19.95



Mini Electronic Ignition Blow Torch

Butane powered with simple push-to-start electronic ignition. The flame is fully adjustable and the unit can be either handheld or placed on the bench top in its stand.

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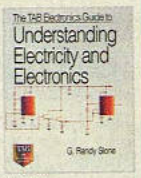

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Covers test procedures with an emphasis on the use of commonly available instruments. Ideal for students, hobbyists, enthusiasts, technicians and professionals.

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- Measures electromagnetic radiation generated by power lines, cables, computers, TVs etc.
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- Beeper sounds when present temperature limits exceeded.
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- Relative mode displays difference between reading and preset value.
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- Features auto power off, data hold, dual temperature and temperature differential displays.
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- Thermocouple range: -40 to 260° C.

Q 1437

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20MHz Dual Trace CRO

- Dual trace, dual trigger & adjustable sweep time (20 steps).
- Variable hold-off, adjustable sensitivity.
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- AC/TV H/TV V trigger coupling.
- Front panel variable rotation and sweep rate from 10nS/DIV to 1s/DIV.
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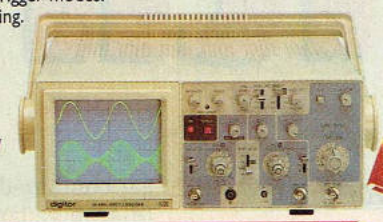
Q 1802



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Pt.4: High Pressure Mercury Lamps

Electric Lighting

Developed in the early 1900s, high pressure mercury lamps are ideal for use where high light outputs are required. Unlike filament lamps, they create light by producing an arc discharge through a mercury vapour gas.

By JULIAN EDGAR

The high pressure mercury lamp emits an intense, white light. It is widely used in industrial, commercial and outdoor applications. In fact, I have two high pressure mercury vapour lamps in my workshop.

Because it is the first lamp discussed in this series that is not instantly recognisable through widespread domestic use, it is helpful to show where the high pressure mercury lamp fits into the scheme of things. Fig.1 shows that electric lamps can generally be divided into two categories – those that bring a filament to high temperature by passing an electric current through it (incandescent lamps) and those that produce light by the excitation of a gas contained between two electrodes (discharge lamps).

A common example of an incandescent lamp is the general service light bulb, while an example of a discharge lamp is a fluorescent tube. However, rather than being a low pressure discharge lamp like a fluorescent tube, the high pressure mercury vapour lamp falls (as the name suggests) into the category of high pressure discharge lamps.

Note that in some publications, the high pressure mercury vapour lamp is abbreviated to MBF, while Philips use an HPL prefix.

History

The first lamp using the principle of a mercury vapour arc was developed in 1901. Peter Cooper Hewitt's

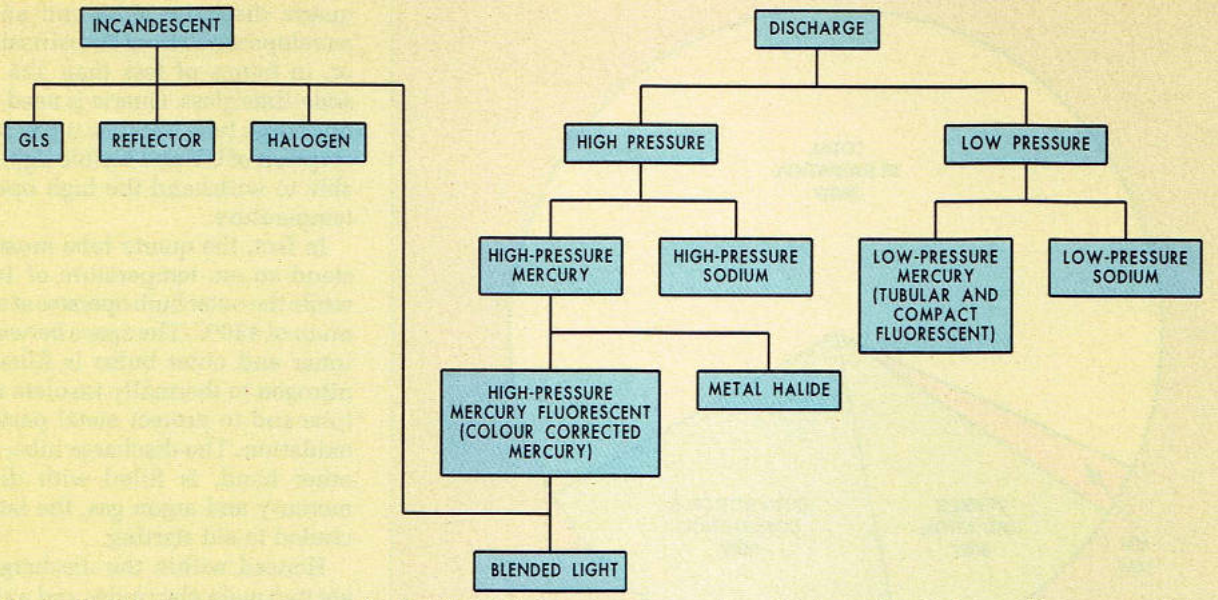


Fig.1: electric lamps can generally be divided into two categories: (1) those that bring a filament to high temperature by passing an electric current through it (incandescent lamps); and (2) those that produce light by the excitation of a gas contained between two electrodes (discharge lamps). (de Boer, J. & Fischer, D. Interior Lighting).

tubular lamp used a mercury pool cathode and an iron anode. When the lamp was tilted, a column of mercury bridged the gap between the cathode and the anode. As the lamp was righted, the mercury column broke and the electric arc discharge started.

This type of lamp was called a Cooper-Hewitt lamp and was widely used in the early 1900s. A 385-watt, 4-foot long tube version had an efficacy of 12.2 lumens/watt (l/W) and was first used in the composing room of the New York Evening Post in 1903.

Interest in mercury vapour lamps increased in the 1930s when 400W lamps were introduced in Europe. These were called "high pressure" lamps, even though the internal gas pressure was actually near atmospheric. The design consisted of an arc tube enclosed within an outer glass bulb and the lumen output matched that of a contemporary 750W incandescent lamp. By the time of the Second World War, 3kW mercury lamps had been introduced.

There were, however, two major problems with mercury discharge lamps. First, when the lamp was mounted horizontally, the arc bowed under the influence of gravity. And if the arc touched the glass wall of the discharge tube, it melted it!

To prevent this, magnets were used to pull the arc away from the glass. Eventually, the development of smaller quartz discharge tubes overcame this problem and did away with the need for magnets.

The second problem was that a mercury discharge produces light at just four visible wavelengths – 404.7nm, 435.8nm, 546.1nm and 577-579nm. The result is a bluish-green-white light that gives poor colour rendering.

In industrial settings, a simple solution to this problem was to mount a 750W tungsten lamp next to a 400W mercury vapour lamp. The excess of reds and oranges from the tungsten lamp counterbalanced their absence from the mercury lamp.

Subsequently, in the 1950s, another

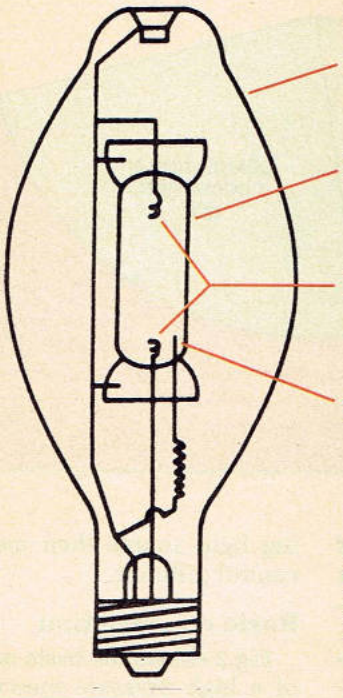


Fig.2: the structure of the high pressure mercury discharge lamp. (Murdoch, J. Illumination Engineering).

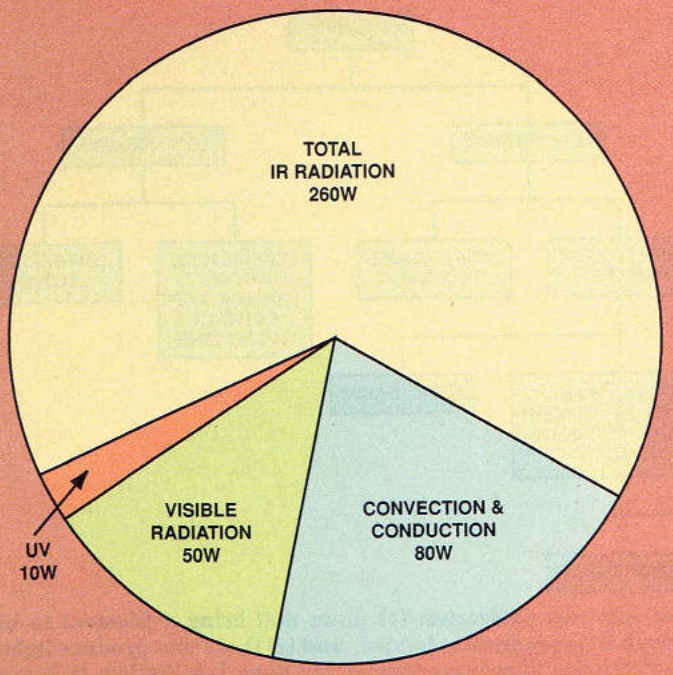


Fig.3: this pie chart shows the energy balance of a clear glass high pressure mercury lamp. (Philips Lighting Manual).

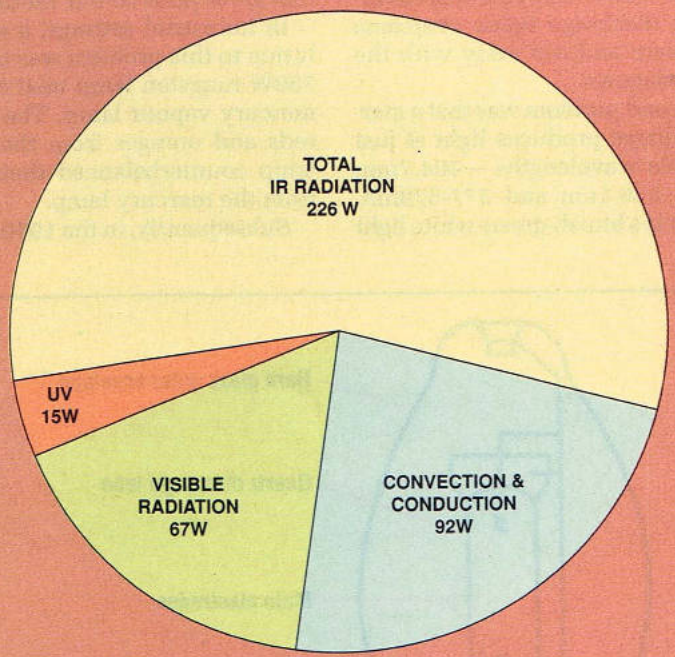


Fig.4: the energy balance of a phosphor-coated high pressure mercury lamp. Note how the phosphor coating increases the output of visible radiation. (Philips Lighting Manual).

solution was found. If the inside of the outer glass bulb is coated with a phosphor, the ultraviolet mercury radiation is converted into visible radiation in the red portion of the spectrum. However the size of the resulting light source then made optical control difficult.

Basic construction

Fig.2 shows the basic construction of a high pressure mercury vapour lamp. The lamp consists of an inner quartz discharge tube and an outer envelope made from borosilicate glass or, in lamps of less than 125 watts, soda-lime glass. Quartz is used for the discharge tube because it has low absorption of UV and visible light and is able to withstand the high operating temperature.

In fact, the quartz tube must withstand an arc temperature of 1000°C, while the outer bulb operates at a maximum of 430°C. The space between the inner and outer bulbs is filled with nitrogen to thermally insulate the arc tube and to protect metal parts from oxidation. The discharge tube, on the other hand, is filled with distilled mercury and argon gas, the latter included to aid starting.

Housed within the discharge tube are two main electrodes and a starting electrode. Each of the main electrodes consists of a tungsten rod upon which a double layer of tungsten wire is wound. During manufacture, the electrode is dipped into a mixture of thorium, calcium and barium carbonates and then heated to convert these compounds to oxides.

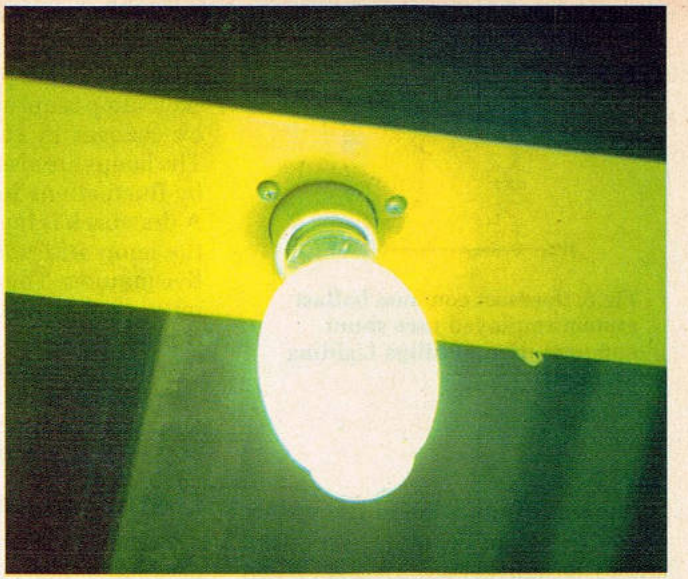
The starting electrode is simply a piece of molybdenum or tungsten wire positioned close to one of the main electrodes. The electrodes are connected through the quartz tube by leads of molybdenum foil. Molybdenum is used because it forms a reliable, gas-tight seal with quartz at the high operating temperature involved.

Mercury lamps are available with clear or coated outer envelopes. Uncoated lamps have a compact light source and are commonly used where accurate directional control is needed; eg, floodlighting. As indicated earlier, an uncoated mercury lamp has an absence of light at red wavelengths. The visible wavelengths emitted are at four distinct wavelengths, corresponding to yellow, green, blue and violet. A significant portion of its energy is also emitted as UV radiation.

Fig.3 shows the energy balance of an uncoated high pressure mercury vapour lamp. A 400 watt lamp produces 50 watts of visible radiation, 10 watts of UV radiation and 260 watts of infrared (IR) radiation. Convection and conduction heat losses are responsible for the remaining 80 watts.

Most mercury lamps have a white phosphor coating on the inner surface of the bulb. This improves colour ren-

The high-pressure mercury lamp goes through a distinct series of phases during start-up. Here the glow discharge is spreading through the discharge tube.



The time between switch-on and a high-pressure mercury lamp producing 80% of its final light output is about five minutes.

dering and also increases the light output because the phosphor converts much of the UV radiation into visible light. Special coatings are also available that give the lamp a lower colour temperature, improved colour rendering, a higher lumen output and higher luminous efficacy. However, the colour rendering properties of mercury lamps are generally poor, with a typical Ra of 45, while colour temperatures from 4200°K to 6000°K are available.

Fig.4 shows the energy balance of a phosphor-coated high pressure mercury vapour lamp. The 400 watt lamp has a visible radiation output of 67 watts, a UV radiation of 15 watts, an infrared radiation of 226 watts and convection and conduction heat losses of 92 watts.

Operating phases

There are three distinct phases during the operation of a high pressure mercury lamp: ignition, run-up and stabilisation.

(1). Ignition: when the lamp is switched on, a high voltage gradient appears between the main electrodes and also between the starting electrode and the nearest main electrode. This ionises the gas in the latter region in the form of a glow discharge, the current being limited by a high-value resistor (typically 25kΩ) wired in series with the starting electrode. The glow discharge then proceeds to spread throughout the discharge tube.

When the glow discharge reaches the furthest electrode, the current increases considerably. This heats the main electrodes until the emission is increased sufficiently to cause the glow discharge to change into an arc. The starting electrode then plays no further part in the process because the resistance of the main arc is far less than that of the starting arc circuit.

At this stage, the lamp has a blue appearance. It is in fact operating as a low pressure discharge lamp, similar to a fluorescent lamp.

(2). Run-up: as a result of the arc discharge, the temperature within the discharge tube rapidly increases. This causes the mercury to gradually vaporise, thereby increasing the vapour pressure and causing the discharge to be concentrated in a narrow band along the tube's axis.

As the pressure within the discharge tube increases, the radiated light is concentrated progressively towards spectral lines of longer wavelengths.

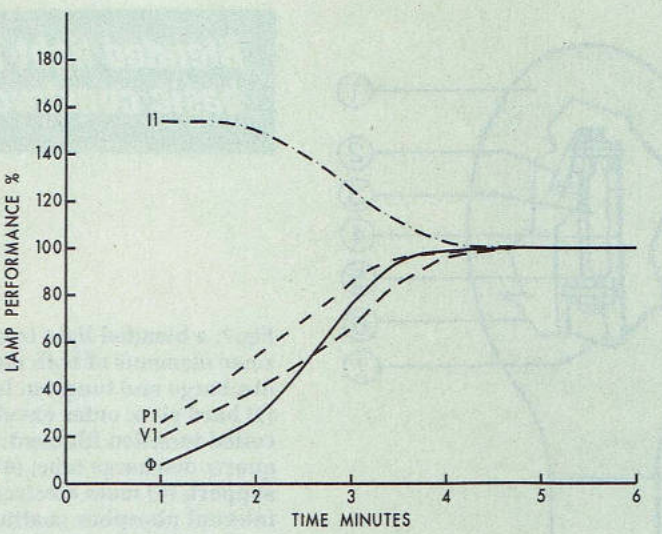


Fig.5: one of the disadvantages of high pressure mercury lighting is the slow start-up. The initial current drawn (I) is high, while lamp power (P), lamp voltage (V) and luminous flux (Φ) take around four minutes to reach normal operating values. (Philips Lighting Manual).

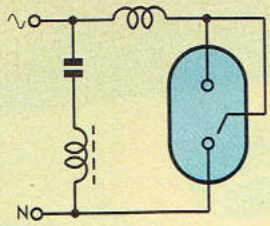


Fig.6: the most common ballast system employed uses shunt compensation. (Philips Lighting Manual).

At the same time, a small proportion of continuous radiation is introduced and so the light becomes whiter. When the internal pressure reaches 2-15 atmospheres (up to 220 psi), the arc stabilises. All the mercury is then vaporised and the discharge takes place in unsaturated mercury vapour.

The time between switch-on and the lamp producing 80% of its final light output is 4-5 minutes. The performance of the lamp during this period is shown in Fig.5.

(3). Stabilisation: as with a fluorescent lamp, a high pressure mercury discharge lamp has a negative resistance characteristic; ie, the current flowing through it would continue to increase if left unchecked. A suitable ballast is therefore required to stabilise the current flow.

Unlike low pressure mercury vapour lamps (fluorescent lamps), the output of a high pressure mercury vapour lamp is not significantly affected by changes in ambient temperature. The lamps are also not greatly affected by fluctuations in the mains voltage. A drawback is that once switched off, the lamp will not re-ignite for about five minutes. This is because the lamp must cool sufficiently to lower the vapour pressure to the point where the arc will re-strike.

A typical coated high pressure mercury vapour lamp has an efficacy of 36-58 lumens/watt.

Control circuit

Because a high pressure mercury discharge lamp includes its own starter, the circuit required is relatively simple. The most common approach is to use shunt compensation, as shown in Fig.6. The capacitor improves the lagging power factor from 0.5 to better than 0.85, with the circuit also reducing lamp current under starting and operating conditions by nearly 50%.

Blended light lamps

As the name suggests, a blended light lamp uses two sources of light. The technology combines aspects of both a high pressure mercury lamp and tungsten filament lamp.

Instead of using an external ballast as a mercury lamp does, a blended light lamp has a built-in ballast in the form of a tungsten filament connected in series with the discharge tube. Light is produced by both the discharge and the glowing filament.

Fig.7 shows the make-up of a blended light lamp. This uses a higher gas pressure within the outer bulb than a mercury vapour lamp to minimise vaporisation of the tungsten filament. As with conventional incandescent lamps, the filling consists mainly of argon with some nitrogen added.

Blended light lamps have the huge advantage of being able to be retrofitted to existing incandescent installations. The lamps have almost twice the efficacy and five times the operating life of incandescent lamps, although both of these characteristics are still much inferior to those of mercury vapour lamps.

The colour rendering of a blended light lamp is much better than that of a mercury lamp, with the lamp having a much wider spectral distribution. Fig.8 shows the spectral output of a Philips HPL-N mercury lamp while Fig.9 shows the spectral distribution of Philips ML blended light lamp. The contribution of the tungsten filament can be clearly seen.

Next month, we'll look at floodlighting for buildings. **SC**

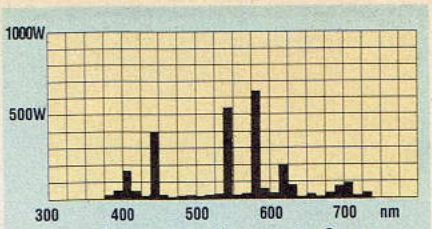


Fig.8: the spectral output of a Philips HPL-N phosphor-coated mercury discharge lamp shows three clear lines. (Philips).

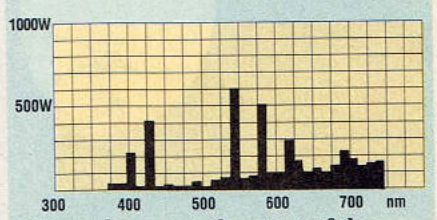


Fig.9: the spectral output of the blended light lamp stills shows the three lines, but in addition there is the higher wavelength emphasis of the tungsten filament. (Philips)

Blended light lamp: basic construction

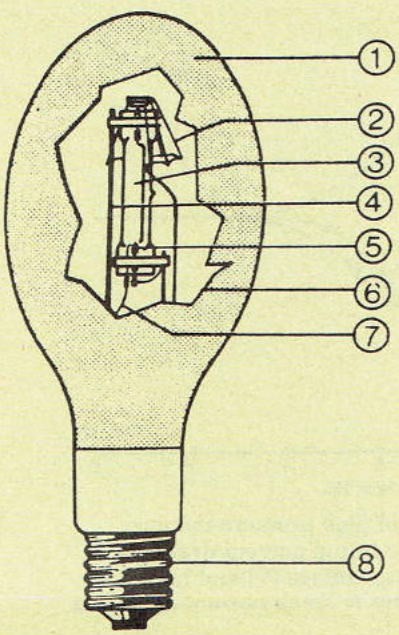


Fig.7: a blended light lamp uses some elements of both mercury discharge and tungsten lamps: (1) hard glass outer envelope; (2) coiled tungsten filament; (3) quartz discharge tube; (4) support; (5) main electrode; (6) internal phosphor coating; (7) lead-in wire; (8) base. (de Boer, J. & Fischer, D. Interior Lighting)

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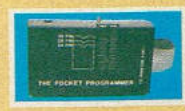

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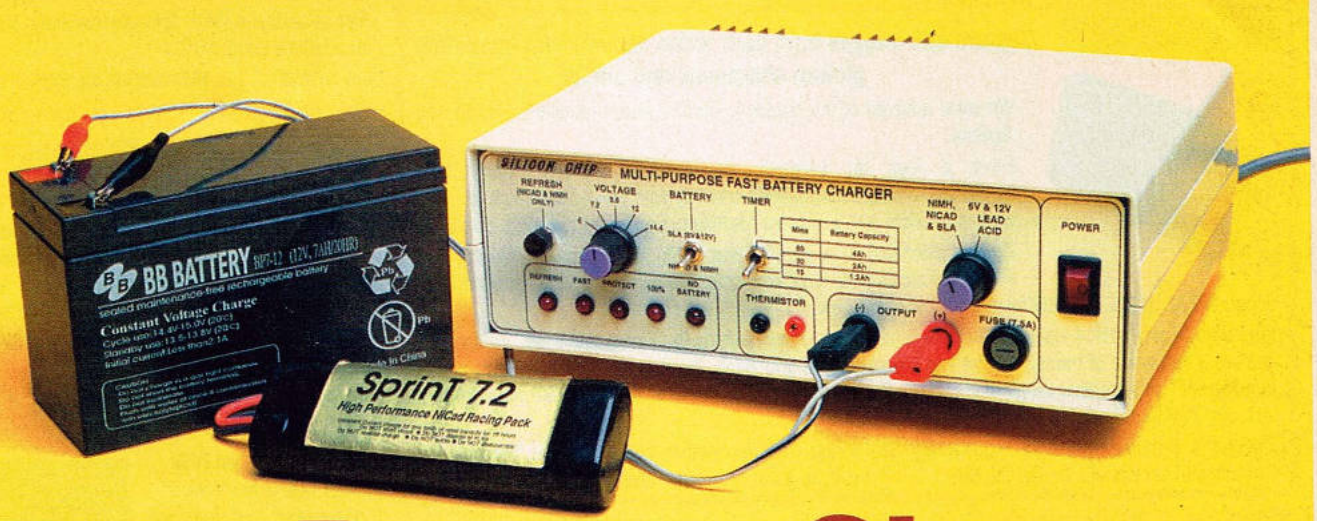

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By JOHN CLARKE

So you got a new battery power tool for Christmas? Great, isn't it? You can use it anywhere, any time and there's no power cord to get in your way. Not so great is when the battery runs down. Unless the tool is a high-priced model with a fast charger, it can take three hours or more to charge the battery. Three hours is a long time when you want to get on with the job.

So fast charging for power tools is the main reason for this new design. But in our never-ending quest for getting more and more performance out of less and less circuitry, we were not going to be content with a design that just did Nickel Cadmium (NiCd) and Nickel Metal Hydride (NiMH) batteries. We wanted to use the basic charger components to cater for Sealed Lead Acid (SLA) and ordinary Lead-Acid batteries as in cars and motor bikes.

Could we do it? As luck would have it ("There is a tide in the affairs of men which taken . . ."), Philips have recently introduced a new battery management chip which takes care of NiCd, NiMH, SLA and Lithium-Ion batteries. So that would take care of most of what we wanted. Could we make it do ordinary Lead-Acid batteries as well? We could, and did, and you see the result here.

Features of the new charger

It is crucial when fast charging batteries that they are not overcharged. If NiCd and NiMH types are given too much charge, they will overheat and be permanently damaged. Nor should SLA and Lead-Acid types be charged beyond a certain voltage or they too will be damaged and their life reduced. The same applies if they are consistently undercharged.

NiCd batteries should also be discharged before recharging. If they are recharged before being discharged they will exhibit the dreaded "memory" effect whereby they will not provide their full discharge capacity. And nor should NiMH batteries be continuously trickle charged since they form dendrites which will eventually short out the cell.

That's a lot of "shoulds" and "should nots" to be catered for but our new

charger design takes care of all these points and a lot more.

The new SILICON CHIP Multi-Purpose Fast Battery Charger provides accurate detection of full charge for NiCd and NiMH batteries and precise end point voltage regulation for SLA and Lead-Acid types. It also has various protection features to prevent fast charge when the battery temperature is too high or low for NiCd and NiMH types and if the battery voltage is initially low for all battery types.

An added feature is the Refresh cycle for NiCd batteries. This discharges the battery so that each cell reaches a nominal 1V before the charger begins to fast charge. Fast charging stops when the cell voltage begins to drop off from a maximum value. There is provision for temperature monitoring as well. Some battery packs have inbuilt thermistors and the charger uses this to detect when the cell temperature begins to rise at a rapid rate.

When fast charging ceases, NiCd & NiMH batteries are topped up at 200mA for about 90 minutes and then trickle charged at 62mA to maintain their capacity before use. This trickle charge comprises short bursts of current which averages to 62mA. These bursts of current prevents dendritic growth within NiMH and NiCd cells.

SLA and Lead-Acid batteries are initially fast charged, tapering off to zero as the battery voltage approaches 2.4V per cell. This corresponds to 14.4V for a 12V battery. Charging automatically starts again when the cell voltage drops to 2.2V or 13.2V for a 12V battery.

Timer & LED indicators

The charger incorporates a timer which stops fast charging after a set period. This prevents overcharging should the end of charge detection methods fail. Normally the timeout is about 1.6 times the expected charge time of the battery, as determined by the capacity and charge current. When charging Lead-Acid batteries, the timer is reset at regular intervals to disable this function. This is because large Lead-Acid batteries require a much longer time to charge than the timer can accommodate.

The Multi-Purpose Charger is housed in a plastic instrument case with a front panel which looks fairly complicated. However, it only has two knobs and a couple of switches and these are used to select the type of battery to be charged, the battery voltage and charge time. It might look complicated but it is quite simple to operate.

Six LEDs are provided on the front panel to indicate the status of the charger. The first of these is the REFRESH LED which indicates when a NiCd battery is being discharged. The discharge cycle is activated by the Refresh pushbutton immediately above the LED.

The FAST LED shows that the charger is delivering maximum current, 6A, to the battery. When the charger deems the battery to be charged, it shows the 100% LED. While this LED is alight, the charger is in "Top off" mode; ie, 200mA charge.

At the end of the "Top Off" mode, the charger goes into trickle mode and all LEDs are off.

The PROTECT LED shows when the battery is shorted or has low voltage

Specifications

- Fast Charge Current ..... nominally 6A
- Topoff current (NiCd & NiMH) 200mA
- Trickle current (NiCd & NiMH) 62mA
- Refresh current (NiCd) 2A
- Refresh discharge end point ..... 1V per cell
- Battery low detect (NiCd & NiMH) ..... 0.3V per cell
- Battery low detect (SLA & Lead-Acid) ..... 0.45V per cell
- Battery high detect (NiCd & NiMH) ..... 2V per cell
- Battery high detect (SLA & Lead-Acid) ..... 2.97V per cell
- Charge end point (SLA & Lead-Acid) ..... 2.4V per cell
- Recharge after end point (SLA & Lead-Acid) ..... 2.2V per cell
- Voltage peak detection (NiCd & NiMH) ..... 0.25% drop in top value
- Temperature rate detection level (NiCd & NiMH) 0.25%
- Under-temperature cutout (NiCd & NiMH) ..... 12°C
- Over-temperature cutout (NiCd & NiMH) ..... 50°C
- Charger over-temperature cutout ..... 80°C
- Fast charge timeout ..... 15, 30 or 60 minutes (nominal)
- Top-off charge time (NiCd & NiMH) ..... about 90 minutes

Features

- Fast charges NiCd, NiMH, SLA and Lead-Acid (car) batteries
- Suitable for 6, 7.2, 9.6, 12 & 14.4V NiCd & NiMH batteries from 1.2Ah to 4Ah.
- Suitable for 6V or 12V SLA batteries from 1.2Ah to 4Ah
- Suitable for 6V or 12V Lead-Acid (vehicle) batteries of more than 1.2Ah
- Includes a discharger for NiCd batteries
- Top-off charging at end of fast charge plus pulsed trickle for NiCd & NiMH batteries
- Voltage limited charge for SLA & Lead-Acid batteries
- Voltage drop (dV/dt) & temperature rise (dT/dt) full charge detection for NiCd & NiMH
- Under and over-temperature cutout for battery
- Over-temperature cutout for charger
- Short circuit battery protection
- Timeout protection
- Fuse protection
- Multi-LED charge indicators

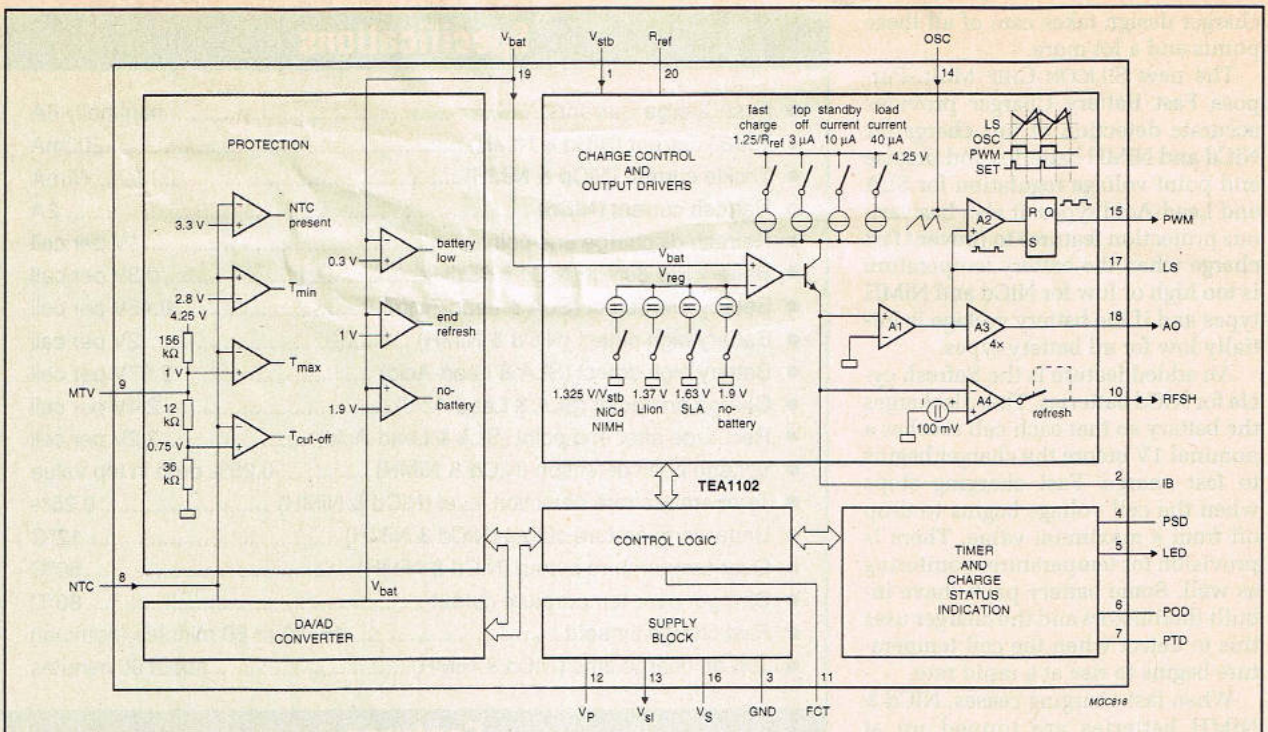


Fig.1: this schematic diagram shows the various functions of the Philips TEA1102 battery management IC.

after a certain period of charge. It will also light with over or under temperature, if the thermistor is connected.

The NO BATTERY LED only lights when NiCd & NiMH battery types are selected and only if the thermistor is not connected to the charger. It simply indicates that the battery is not connected or has a high impedance.

Battery management IC

As noted above, all of the charging features described so far are provided by virtue of a battery management IC made by Philips Components. It is designated the TEA1102. Its block diagram is shown in Fig.1. We downloaded this diagram and the data sheet from the Philips web site at WWW.SEMICONDUCTORS.PHILIPS.COM

The operation of the TEA1102 is rather complex and comprises analog and digital circuitry which can be divided into six separate sub sections as shown on the block diagram.

Starting at the top righthand corner of Fig.1, the charge control and output driver section comprises a current source, battery type selection, oscillator, comparators, amplifiers and a pulse width modulation (PWM) and analog control output.

Battery voltage is monitored at the Vbat input (pin 19, top of diagram) and this is compared against Vreg which sets the endpoint voltage for charging the selected battery type. Options are NiCd (Nickel Cadmium) & NiMH (Nickel Metal Hydride), Lithium-Ion and SLA (Sealed Lead Acid). Note that we have not used the Lithium-Ion facility as these batteries are comparatively rare in consumer equipment, apart from computer backup batteries.

There is a different Vreg selection for each type of battery but these do not necessarily correspond to the "endpoint" voltage for each cell type.

The comparator monitoring Vbat and Vreg controls the constant current source transistor which is supplied with one of four currents; fast charge, top off, standby and load. At switch on, the TEA1102 is reset and fast charge mode is selected. This fast charge is set by a resistor at Rref (pin 20) to select the current flow to the IB output (pin 2).

The current from the IB output pin flows through an external resistor to develop a voltage which is monitored by the internal op amps A1 and A4. A1's output is amplified by A3 to give an analog control output (pin 18) and is compared in A2 against a triangle waveform set by the oscillator at pin 14. A2's output is a pulse width modulated (PWM) signal which is used to control the charge current.

PWM operation

The oscilloscope waveform of Fig.2 gives us an idea of how this works. The lower trace triangle waveform is the oscillator output and the horizontal cursor line represents the DC output of A1 (pin 17). The upper trace is the PWM output to drive a switching transistor. This PWM output goes high when the oscillator waveform goes below the A1 output. If the current decreases, the A1 output will rise and produce a wider PWM signal to increase the current.

The Vbat input at pin 19 also connects to the battery low, end refresh and no battery comparators in the Protection block. These are to prevent fast charge when the battery is low, cease the refresh at 1V per cell and prevent a high output voltage with no battery connection. The Vbat signal also is applied to the Analog to Digital converter and Digital to Analog converter, shown as the DA/AD converter

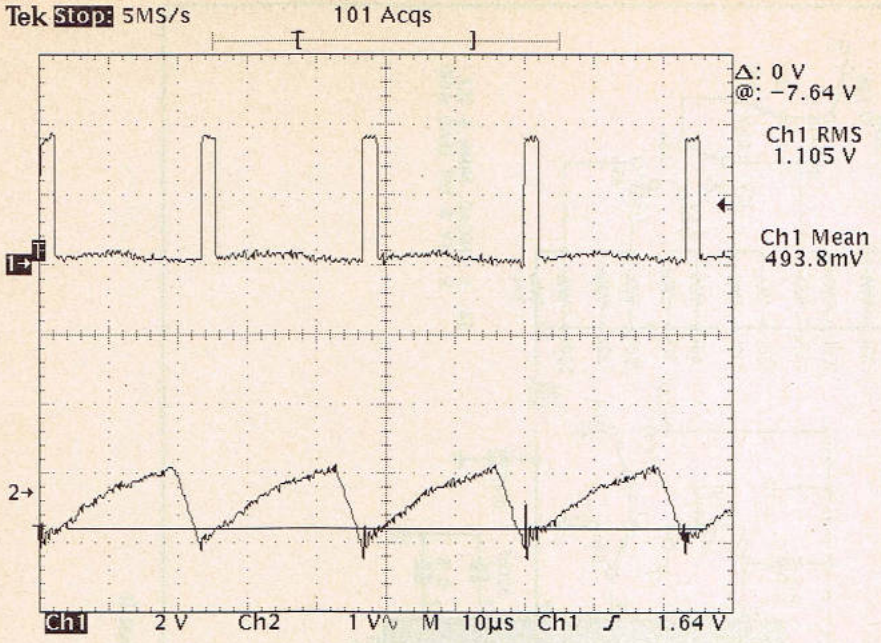


Fig.2: these waveforms show the switchmode operation of the charger. The lower trace triangle waveform is the oscillator output and the horizontal cursor line represents the DC output of A1 (pin 17). The upper trace is the PWM output to drive a switching transistor. This PWM output goes high when the oscillator waveform goes below the A1 output. If the current decreases, the A1 output will rise and produce a wider PWM signal to increase the current.

on the block diagram of the IC.

The DA/AD converter monitors battery voltage when charging NiCd & NiMH batteries. As the battery is charging the voltage gradually increases and at a regular interval, the A/D converter samples the voltage and stores it as a digital value if the voltage has increased from the previous reading. When the voltage begins to fall the lower voltage is not stored but compared with the analog voltage resulting from the digital stored value. A fall of 0.25% indicates that the battery is charged and the charger will switch to trickle mode.

The DA/AD converter also monitors the thermistor voltage via the NTC input at pin 8. If the thermistor is connected the DA/AD converter switches off fast charge when there is a sudden rise in temperature of the battery which also indicates full charge. Note that fast charge will be switched off if there is a low or high temperature detected by the T_{min} and T_{max} comparators.

The "NTC present" comparator detects the connection of the thermistor. The $T_{cut\text{-}off}$ comparator is the detector for the change in battery temperature which switches on for a 0.25% rate of rise in temperature. The MTV input (pin 9) can be used to calibrate the thermistor temperature at T_{max} although we have not used this feature.

The Control Logic section monitors and sets the operation of the various blocks within the IC. Voltage on the FCT input (pin 11) selects the type of battery to be charged. The Supply Block takes its supply at the V_p input (pin 12) and produces a reference voltage at the V_s output (pin 16). This reference provides an accurate and stable source for the battery end point voltages.

The V_{sl} output (pin 13) is used to switch on power to the indicating LEDs. This is necessary since the LEDs are driven by dual purpose outputs which also provide programming for the timers. These pins are initially monitored at power on to check what

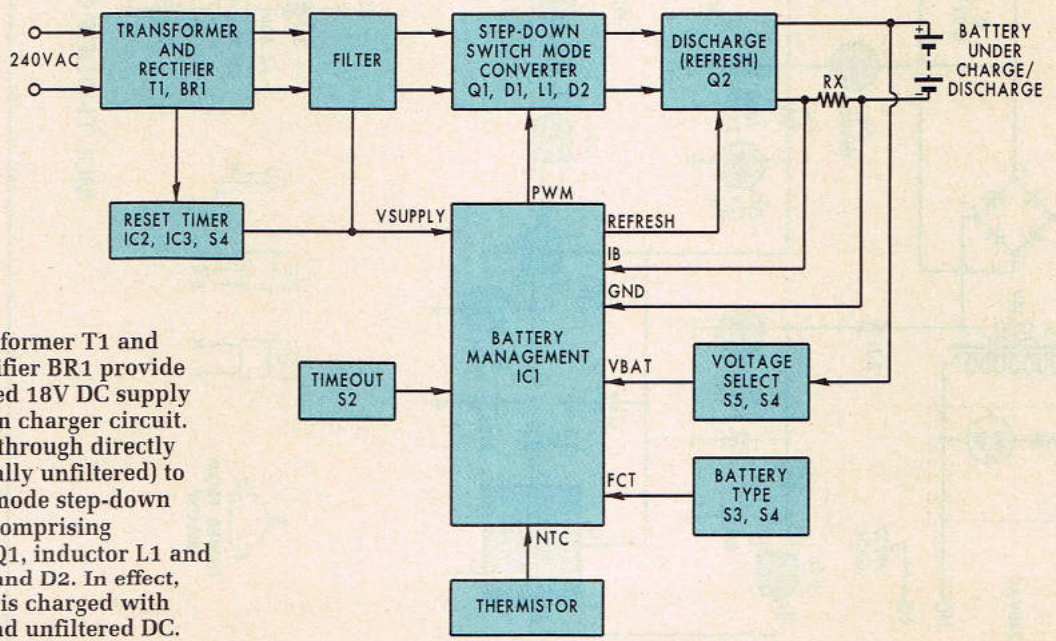


Fig.3: transformer T1 and bridge rectifier BR1 provide an unfiltered 18V DC supply for the main charger circuit. This is fed through directly (ie, essentially unfiltered) to the switchmode step-down converter comprising transistor Q1, inductor L1 and diodes D1 and D2. In effect, the battery is charged with chopped and unfiltered DC.

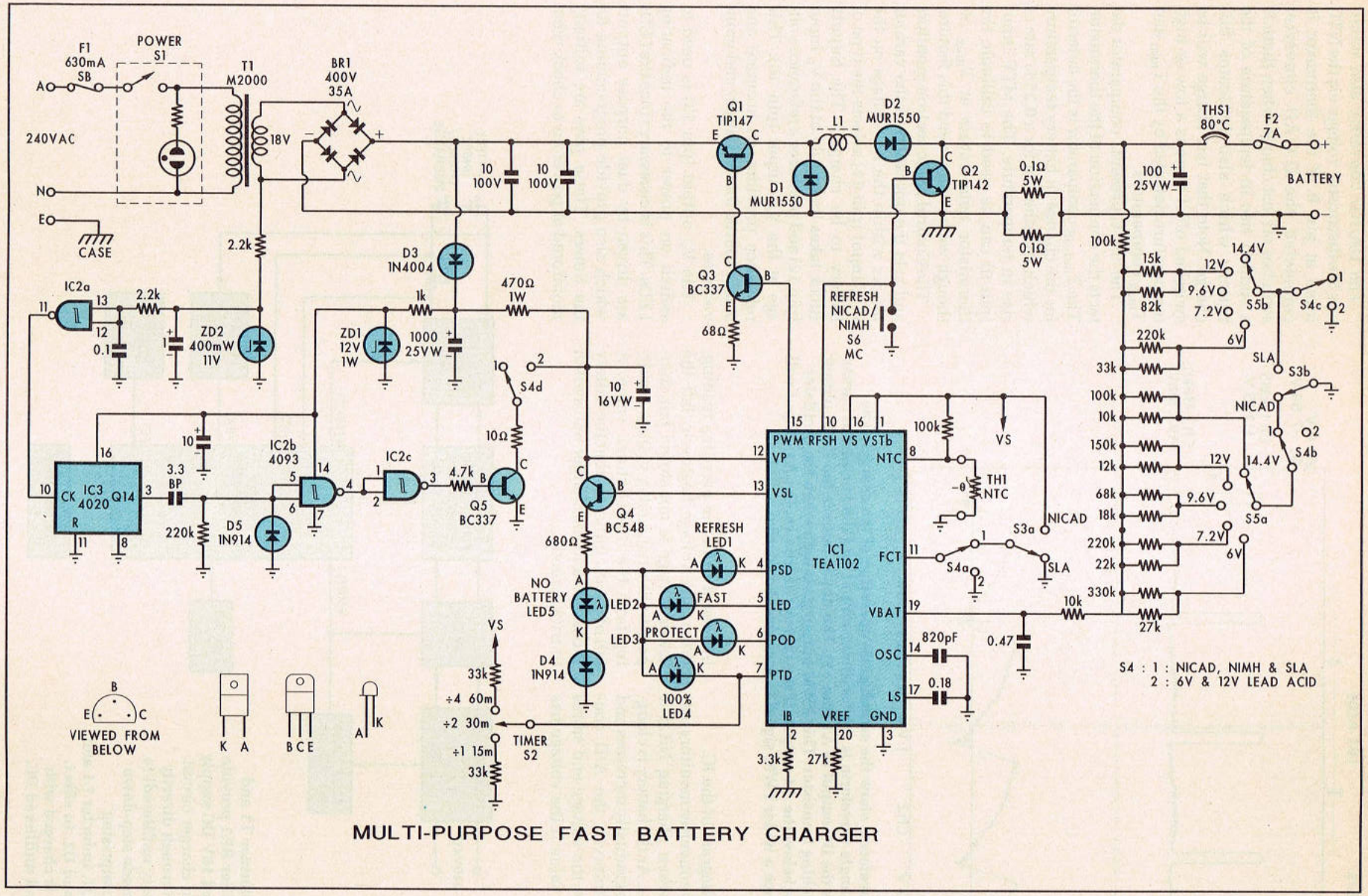


Fig.4: As you can see, there is quite a lot of switch circuitry hanging off the TEA1102, emphasising the fact that it does most of the work. IC2 & IC3 provide a timer reset function so that Lead-Acid batteries can be charged.

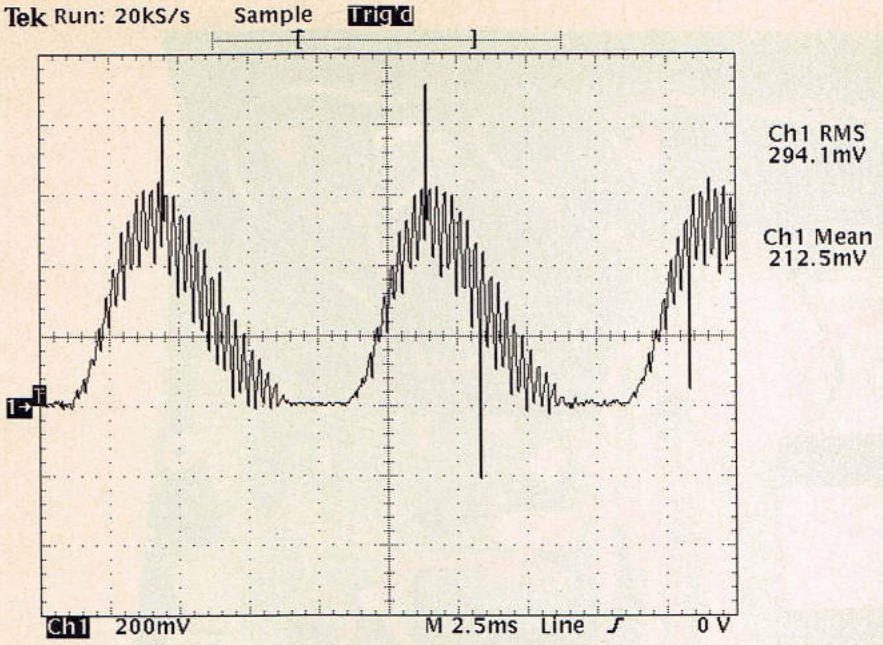


Fig.5: this is the current waveform across the sensing resistor Rx. Its value is 0.05Ω and the RMS voltage reading is 294mV or 5.88A. The mean value (and the reading obtained on a multimeter set on DCV) shows only 212mV or 4.24A.

options are set, before the LEDs are powered.

Block diagram

Fig.3 shows how we have used the TEA1102 battery management IC in our circuit. Transformer T1 and bridge rectifier BR1 provide an unfiltered 18V DC supply for the main charger circuit. This is lightly filtered to provide DC for the control circuitry but is fed through directly (ie, essentially unfiltered) to the switchmode step-down converter comprising transistor Q1, inductor L1 and diodes D1 and D2.

In effect, the battery is charged with chopped and unfiltered DC. This allows a considerable saving on electrolytic filter capacitors as well as reducing power losses in the main series pass transistor, Q1.

Circuit description

Fig.4 shows the full circuit for the Multipurpose Fast Battery Charger. It comprises three ICs including the TEA1102, two power transistors and diodes and not a great deal else. As you can see, there is quite a lot of switching circuitry hanging off the TEA1102, which emphasises the fact that it does most of the work.

Power for the circuit comes from an 18V 6A transformer which feeds a bridge rectifier and two 10µF polyester capacitors. These capacitors supply the peak switching current to the switchmode supply comprising transistor Q1, diode D1 and inductor L1.

The Pulse Width Modulation output at pin 15 of IC1 drives transistor Q3 which operates as a pulsed "current sink" pulling current out of the base of Q1. The 68Ω resistor in the emitter of Q3 sets the current pulses to about 34mA and these ensure that Q1 is turned on hard.

The collector current from Q1 flows through inductor L1 and diode D2 into the battery load. Each time Q1 switches off, the fast recovery diode D1 provides a current path so that the energy stored in the inductor can be fed into the battery. Diode D2 prevents the battery from feeding current back into the switchmode circuit when the charger reaches the end of its cycle.

The 100µF capacitor connected across the battery is there to filter the supply when no battery is connected so that the "no battery" detection will operate within IC1.

The charge current is detected in the 0.05Ω resistance comprising two 0.1Ω resistors connected in parallel to the emitter of Q2. This "ground" point is tied to pin 2 of IC1 via a 3.3kΩ resistor and this allows IC1 to monitor the current.

Operation is as follows: The Vref output at pin 20 which has a 1.25V supply sets the current flow out of the IB pin so that it is equal to 1.25V/27kΩ = 46µA. This current produces a voltage across the 3.3kΩ resistor and this is used to set the maximum current from the charger.

Fig.5 shows the current waveform across the sensing resistor Rx. Its value is 0.05Ω and the RMS voltage reading is 294mV or 5.88A. The mean value (and the reading obtained on a multimeter set on DCV) shows only 212mV or 4.24A.

The 27kΩ resistor at pin 20 also sets the oscillator frequency in conjunction with the 820pF capacitor at pin 14. Frequency of oscillation is about 50kHz which sets the PWM switching speed and the timeout periods.

The Timeout period is adjusted by the switch setting at pin 7. When pin 7 is pulled low via the 33kΩ resistor at switch S2, the timeout is about 15 minutes. An open setting of S2 increases the timeout by a factor of two and when S2 pulls pin 7 high, the timeout is increased again by a factor two. These last two settings give the 30-minute and 60-minute settings respectively.

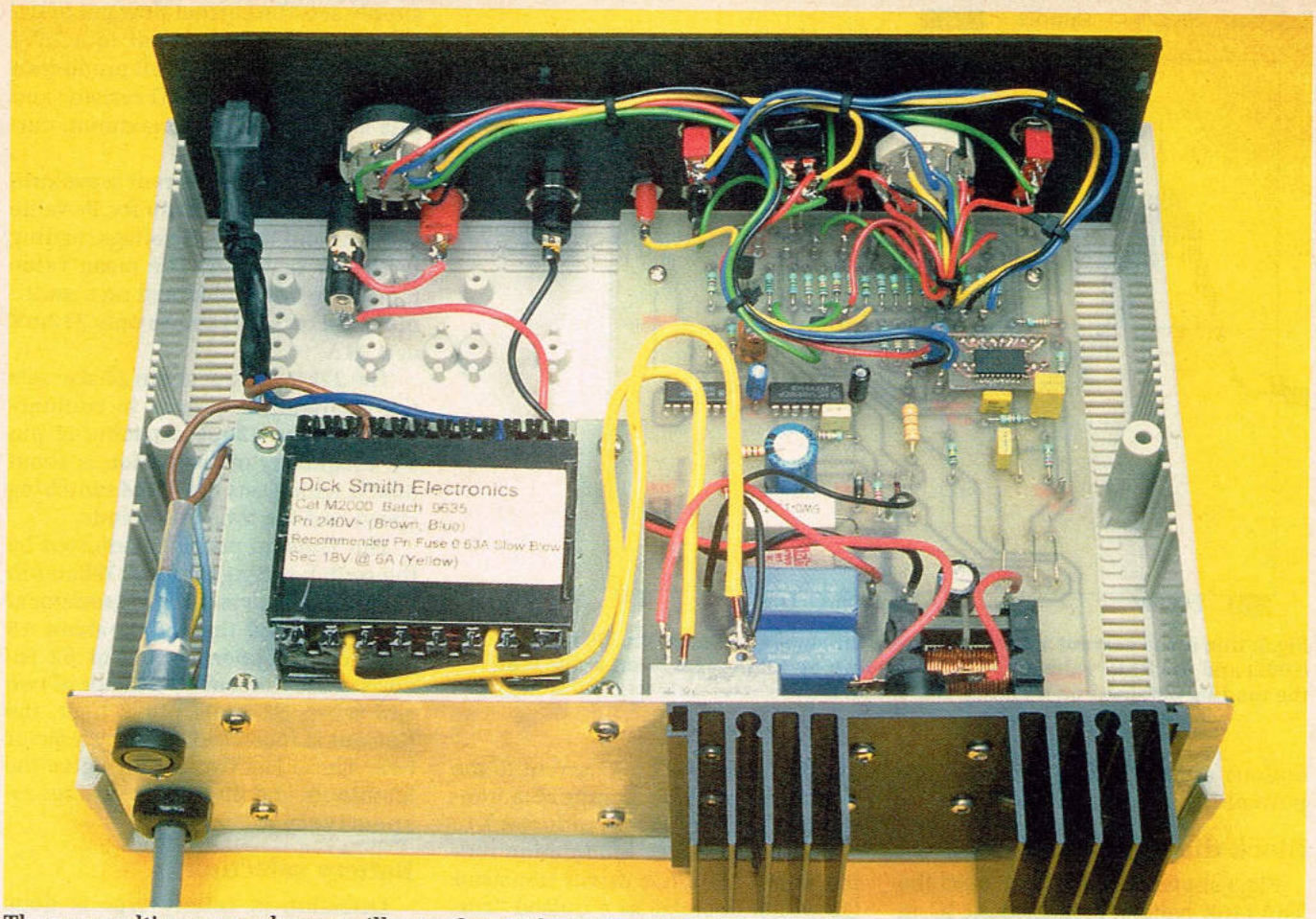
Battery selection

Detection of battery type is done with the FCT (Fast Charge Termination) input, pin 11. When pin 1 is grounded via switches S3a and/or S4a, the SLA battery charge procedure is used by IC1. S4a ensures that pin 11 is at ground regardless of the position of S3a when S4 is in position 2 when 6V or 12V Lead-Acid batteries are being charged. This prevents Lead-Acid batteries being charged as NiCd or NiMH types which would lead to overcharging.

The NiCd and NiMH charge cycle is selected when pin 11 is connected via S3a to the 4.25V reference at pin 16. The V_{stb} (pin 1) input selects trickle charging after the NiCd or NiMH batteries are charged rather than the voltage regulation option when pin 1 is open circuit.

Pin 19, the V_{bat} input monitors battery voltage via a switched voltage divider connected via a 10kΩ resistor and 0.47µF capacitor filter. The divider for NiCd & NiMH batteries is via S5a, catering for 6V, 7.2V, 9.6V, 12V and 14.4V packs. The divider for SLA and Lead-Acid batteries is via S3b and S5b, catering for 6V and 12V.

Pin 8, the NTC input, detects the



The new multi-purpose charger will cater for NiCd, NiMH, SLA and Lead-Acid (car) batteries. Intended mainly as a fast charger for power tools and R/C gear, it does double duty with car and SLA batteries.

presence of a thermistor in the battery pack. The 100kΩ resistor pulls pin 8 up to +4.25V when the thermistor is disconnected and to about +2V when it is connected, at normal room temperature. As the thermistor heats up, the rise in temperature on the battery should correspond to a voltage reduction; ie, dV/dt detection. If this is not detected before the thermistor voltage reaches 1V, the fast charge will cease because of over temperature.

LED indication is provided on the LED, POD, PTD and PSD pins and controlled via the V_{sl} output. At power up, all LEDs are off and the IC looks at the POD, PTD and PSD pins to check the division ratio programming set on these pins. After this, the LEDs can be lit when V_{sl} goes high to turn on transistor Q4 which feeds them via the 680Ω resistor. If LEDs 1-4 are off then the "No battery" indicator, LED5, can light. However, if any of the other LEDs are alight, LED5 will extinguish. This is because LED5 requires more voltage than the other LEDs due to the series diode, D4.

Refresh cycle

Transistor Q2 turns on to discharge NiCd batteries when pin 10 of IC1 is momentarily shorted to ground via pushbutton S6. Note that the switchmode output at pin 15 is low while Q2 is turned on. Current flow through Q2 and the battery is also via the 0.05Ω resistor and is detected at the IB input at pin 2. This discharge current is regulated to 2A.

Power for IC1 comes from the positive side of the bridge rectifier which charges a 1000µF capacitor via diode D3. The diode reduces the ripple on the capacitor and also prevents the charging current for the battery being drawn from this capacitor. A 470Ω resistor supplies current to pin 12 of IC1 which has an internal 12V zener diode regulator. A 10µF capacitor decouples the supply.

A 1kΩ resistor supplies current to a separate 12V zener diode, ZD1, to power IC2 and IC3. These two ICs form the reset timer.

The AC side of bridge rectifier BR1 supplies an 11V zener diode, ZD2, via a 2.2kΩ resistor. The zener diode limits the resulting 50Hz signal to +11V and -0.7V and this is fed via an RC filter to Schmitt trigger IC2a which squares up the waveform.

This signal is then applied to the clock input of IC3, a 14-stage binary counter. The resulting output at pin 3 goes high once every 5.5 minutes. The high output is fed to inverter IC2b via the 3.3µF capacitor and then to inverter IC2c. IC2c then drives transistor Q5 which switches the supply of IC1 to ground via a 10Ω resistor. This action resets the internal timer of IC1. This cycle repeats while ever S4d is in position 2 which corresponds to charging for Lead-Acid batteries.

Hence, the only reason why IC2 & IC3 and the associated circuit have been included is to allow lead-acid batteries to be charged.

Next month, we will present the full construction details for the Multi-Purpose Fast Charger. **SC**

This 2-line Telephone Exchange Simulator can be used to test telephone handsets, fax machines, modems, answering machines and other telephone equipment such as diallers on burglar alarms. It contains the all the circuitry necessary to accept decadic (pulse) or DTMF (tone) dialling.

Telephone Exchange Simulator For Testing

Have you ever wanted to test the modem section on a piece of electronic equipment but were unable to afford the luxury of a small PABX? Or are you in the production side of electronics and need to simulate a telephone exchange to test the finished product? Well, this Telephone Exchange Simulator can overcome these problems.

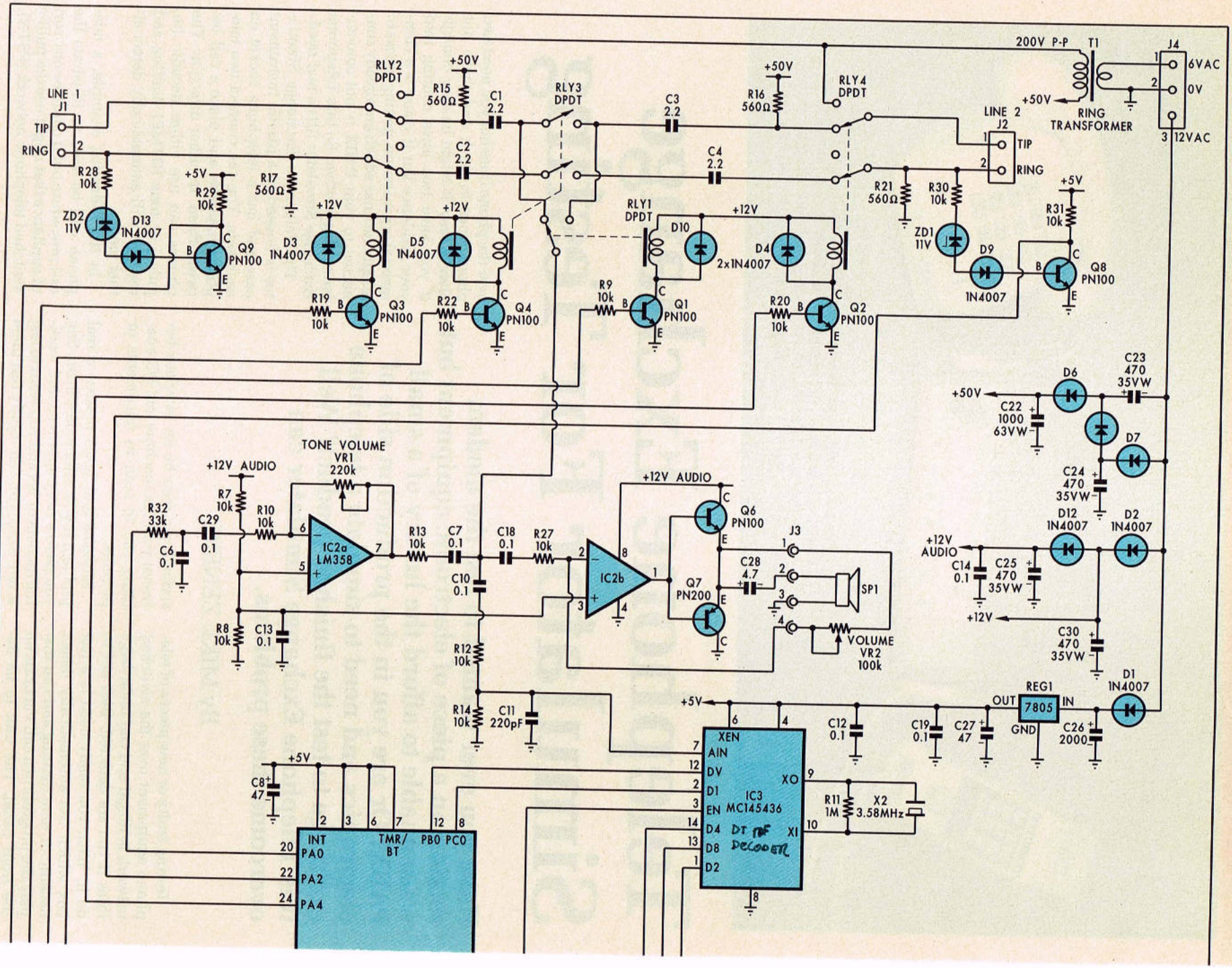
By MIKE ZENERE

Testing faulty or new pieces of telephone equipment over the switched network is illegal and can incur large fines if you are detected. Best not to do it. What you really need is a test box which can automatically detect decadic or tone dialling and can display the progress of a call via LEDs on the front panel. The unit to be described can also be an interface between your fax machine and PC, enabling you to scan in documents or pictures.

Modems and faxes present a real problem if you want to test them. Say you have a fully approved and working modem or fax and you want to test it out. Sure, you can legally test them over the phone lines but you need two phone lines to do it and that's not always easy. It might be easy enough if you have two lines coming into your residence but if yours is a commercial organisation, getting access to telephone lines which are already connected to your PABX is not convenient or legal either. So this Telephone Exchange Simulator fills a real need.

The Telephone Exchange Simulator is housed in a plastic instrument case and has a telephone socket on each side. You can connect two telephone handsets and place a call between them, in either direction. The phones can use either decadic (ie, pulse) or tone (DTMF) dialling and the unit will automatically detect either mode.

In the following example, a telephone will be used to illustrate the call procedure but it could be any sort of appliance that might use the public switched telephone network (PSTN).


LINE 1
J1
TIP
RING
RLY2 DPDT
RLY3 DPDT
RLY4 DPDT
RLY1 DPDT
+50V
R15 560Ω
R16 560Ω
C1 2.2
C2 2.2
C3 2.2
C4 2.2
200V P-P
T1
RING TRANSFORMER
J4
6VAC
0V
12VAC
LINE 2
J2
TIP
RING
R28 10k
R29 10k
R17 560Ω
R21 560Ω
R30 10k
R31 10k
+5V
+12V
ZD2 11V
D13 1N4007
ZD1 11V
D9 1N4007
D3 1N4007
D5 1N4007
D10
D4 2x1N4007
Q9 PN100
Q8 PN100
Q3 PN100
Q4 PN100
Q1 PN100
Q2 PN100
R19 10k
R22 10k
R9 10k
R20 10k
C23 470 35VW
C22 1000 63VW
D6
D7
C24 470 35VW
TONE VOLUME
VR1 220k
+12V AUDIO
R7 10k
R10 10k
R32 33k
C29 0.1
C6 0.1
IC2a LM358
R13 10k
C7 0.1
C18 0.1
R27 10k
IC2b
Q6 PN100
Q7 PN200
J3
C28 4.7
SP1
VOLUME VR2 100k
C10 0.1
R8 10k
C13 0.1
R12 10k
R14 10k
C11 220pF
D12 1N4007
D2 1N4007
C14 0.1
C25 470 35VW
C30 470 35VW
REG1
7805
OUT
IN
GND
D1 1N4007
C12 0.1
C19 0.1
C27 47
C26 2000
C8 47
IC3 MC145436
XEN
AIN
DV
D1
EN
D4
D8
D2
XO
XI
R11 1M
X2 3.58MHz
DT DF DECODER
INT
PA0
PA2
PA4
TMR/ BT
PB0 PC0

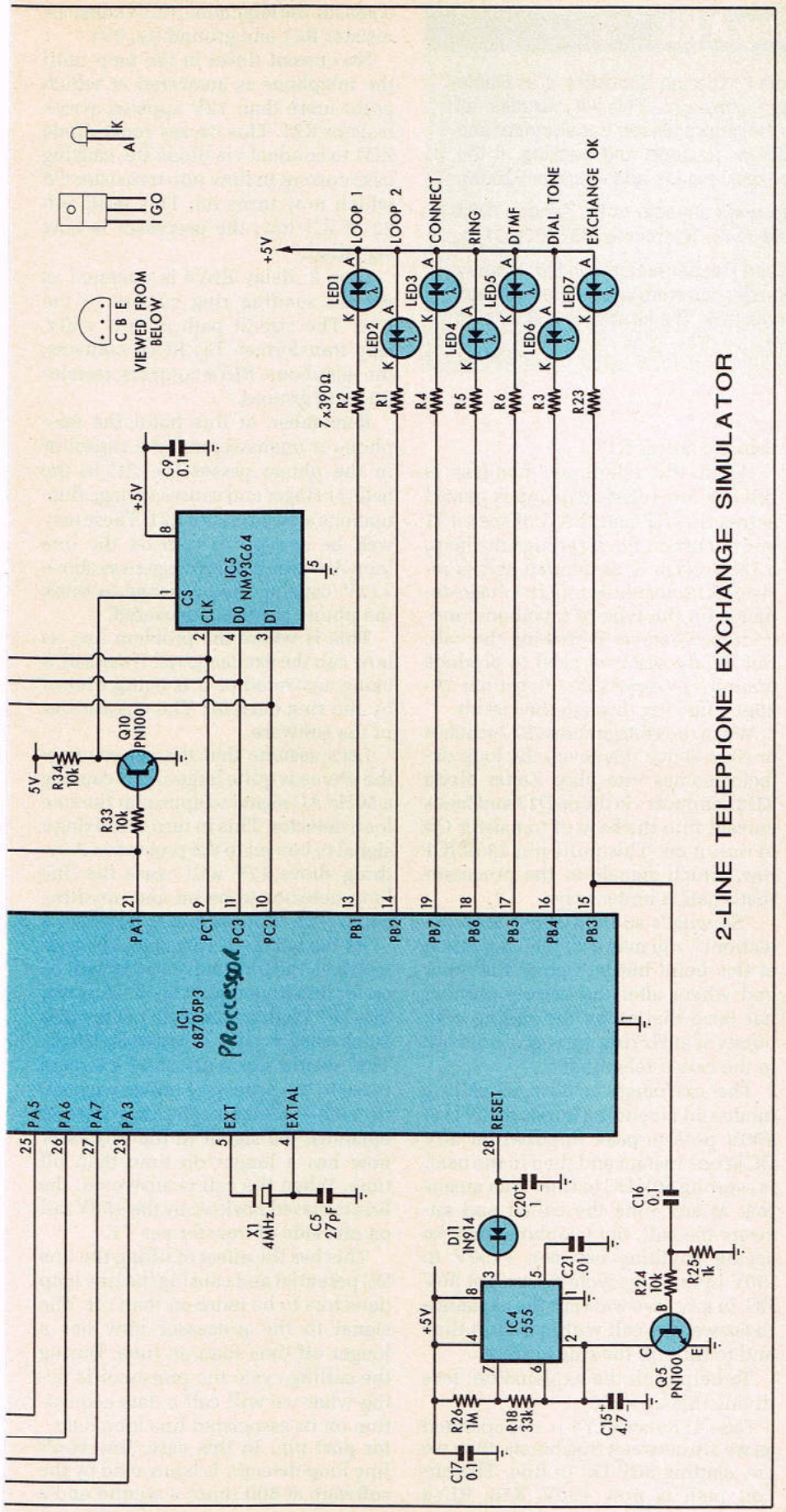


Fig.1 (left): the heart of the circuit is the 68705P3 processor which controls all the phone functions apart from DTMF decoding which is done by IC3.

A call is made in this way: lift the handset of one telephone and listen for dial tone. At this point both the LOOP LED and the DIAL TONE LED should be on, signifying that a call is in progress. Also an audible sound should be heard from the internal speaker. Start dialling, noticing that the dial tone disappears and either the DTMF LED or the LOOP LED are flashing, in accordance with the digits dialled. If the exchange receives a correct number, ring tone will be heard in both the speaker and the ear piece as well as an audible ringing of the phone.

If the called phone is answered, the second LOOP LED and the CONNECT LED will light, showing that the call is connected. A speech path is now formed from one telephone to the other.

This simple test procedure will not only enable you to test typical telephone handsets but it is also very useful for testing cordless phones. And as already noted, it will let you test fax machines and modems and answering machines too.

Some useful terminology

Listed below are some terms that may be useful:

On hook: the telephone receiver is on the phone and the phone is disconnected from the line.

Off hook: the telephone receiver is off the phone and the phone is connected to the line.

Dial tone: the sound you hear when you first pick up the receiver before you start dialling.

Ring tone: the sound you hear when the exchange is calling the other end.

Busy tone: the sound you hear when you have called the other end but their phone is in use.

No progress tone: the sound you hear when the wrong number has been dialled.

How it works

Fig.1 shows the complete circuit of the Telephone Exchange Simulator. At the heart of the circuit is IC1, a

Where To Buy A Kit

A complete kit of parts for the Telephone Exchange Simulator is available from the author who owns the design copyright. This kit includes all components, including the programmed microprocessor, transformers and case. The price is $190.00 plus $8.50 for postage and packing. If the documented source code is required on disk, please add a further $20.00.

Please make payments (Postal Orders only) payable to M. Zenere, 1/83 Headingley Road, Mt. Waverley, Victoria 3149. Telephone (03) 9806 0110.

Also available is a kit for the Magnetic Card Reader featured in the January 1996 issue of SILICON CHIP. The Card Reader can store up to eight magnetic cards in memory and can be used as a door lock. The kit price is $68.00 plus $7 for postage and packing.

68705P3 single chip microcontroller. This device is a complete computer on a chip and controls the entire exchange simulator.

This device is somewhat old now but as they are in plentiful supply and fulfil the requirements of this project, they were used. A review of the functions of the 68705P3 was featured in the September 1992 issue of SILICON CHIP.

Another key feature of the circuit is the two Line Loop Detectors, comprising zener diode ZD1, diode D9 and transistor Q8 for the first detector and ZD2, D13 and Q9 for the second detector.

Line loop detectors

Line loop detectors are the curse of the telephone exchange designer and at first glance these two line loop detectors may appear to be quite simple but the amount of design time and testing that went into this part of the circuit was enormous. In fact, more time was spent getting this part of the circuit to work properly than was spent on the rest of the project, including writing the article.

The line loop detectors are used to sense a low resistance loop in the line; eg, someone has lifted a handset.

It was decided that a loop current of 20-25mA minimum would be required to cause the Simulator to accept that a call was being made. Looking at the line one circuit, we can see that the basic telephone circuit is made up of +50V, resistor R15, RLY2 contacts, the telephone handset itself, RLY2 contacts, resistor R17 and ground. With the telephone on-hook, the line appears as an open circuit to the exchange and as such, no voltage is developed across R17.

When the telephone handset is lifted, a low resistance loop is placed across the TIP and RING of socket J1 and as current flows through the loop, a DC voltage is developed across resistor R17. Just how much voltage depends on the type of telephone, modem or whatever is making the call. But in any case, we need to produce around 12V across R17 to get our 20-25mA flowing through the circuit.

When the voltage across R17 reaches or rises above this level, the loop detector comes into play. Zener diode ZD2 conducts via diode D13 and feeds current into the base of transistor Q9 to turn it on. This pulls pin 23 of IC1 low, which signals to the processor that a call is under way.

"So what's so hard about loop detection?" you may ask. Well not much at this point but let's go to the other end where after the correct number has been dialled by the calling end, bursts of 50Hz ring current are fed out to the called telephone.

The exchange is now in calling mode and is sending bursts of 50Hz at 200V peak-to-peak imposed on 50V DC at one instant and then in the next, is sending 50V DC to line. This means that at any time the called end answers the call, the telephone may be seeing anything between +150V to -50V in the ring cycle or straight 50V DC. In any case we want the exchange to answer the call within a short time and to turn off the ring current.

To help with the explanation, let's divide this up a bit.

Case 1: Relay RLY4 is not operated as we are between ring bursts, thus we are sending 50V DC to line. The circuit path is now +50V, R16, RLY4 contacts, the telephone, RLY4 contacts, resistor R21 and ground (ie, 0V).

No current flows in the loop until the telephone is answered at which point more than 12V appears across resistor R21. This causes zener diode ZD1 to conduct via diode D9, causing base current to flow into transistor Q8 which now turns on. This pulls pin 22 of IC1 low; the processor is now signalled.

Case 2: Relay RLY4 is operated as we are sending ring current to the line. The circuit path is now +50V, ring transformer T1, RLY4 contacts, the telephone, RLY4 contacts, resistor R21 and ground.

Remember, at this point the telephone is unanswered but a capacitor in the phone passes the AC to the bells or ringer and causes voltage fluctuations across resistor R21. These may well be enough to turn on the line loop detector if the voltage rises above +12V, causing the exchange to think the phone has been answered.

This is where the problem lies, as how can the exchange tell if the call is being answered or it is being tricked by the ring current? The answer lies in the software.

Let's assume that the capacitor in the phone is quite large and is causing a 50Hz AC signal to appear at the line loop detector. This in turn is causing a signal to be sent to the processor. Anything above 12V will cause the line loop detector to be on and anything below 12V will cause it to be off.

As the 50Hz AC ring signal is symmetrical, the line loop detector will be on for less time than it is off. How can this be? Well, a complete cycle takes 20ms so each peak is active for 10ms. This would normally send a square wave to the processor but as we need to reach +12V before the loop detector operates, the signal to the processor now has a longer on time than off time. When the call is answered, the line is biased positive by the +50V rail on one side of transformer T1.

This has the effect of lifting the line DC potential and causing the line loop detectors to be more on than off. The signal to the processor now has a longer off time than on time. During the calling cycle the processor is doing what we will call a data acquisition on its associated line loop detector port pin. In this case, line two's line loop detector is being read by the software at 800 times a second and a

record is kept of its on and off times. This information is sent through a subroutine in software and if the conditions are right the call is deemed to be answered.

Power supplies

The Telephone Exchange Simulator requires five different supply rails to work properly and these are derived mainly from a 12V AC transformer. The different sections are described below.

The logic side of the board draws around 150mA and its 5V rail is derived from the 12V secondary winding using a half-wave rectifier D1 and a 2000µF filter capacitor C26. This feeds 3-terminal 5V regulator REG1.

There are two 12V supplies one of which powers the audio section of the circuit involving dual op amp IC2 while the other 12V rail powers the relays. Separating the relay circuitry from the op amp section helps reduce noise and distortion.

The first 12V source is derived via diode D2 and capacitor C30, while the second 12V rail source is derived from diode D1 and capacitors C25 and C14.

+50V supply

Three diodes, D6, D7 & D8 and three capacitors C22, C23 & C24 make up a voltage tripler from the 12VAC and this produces around 50VDC. This voltage is used to drive the telephone handsets and provide our speech path to the other end.

200V supply

The voltage to ring a standard issue Telstra phone is quite high and considering a customer could be over 4km from the exchange a voltage of 200V peak-to-peak (70V RMS) is required. The simplest way to provide this is to use a step-up transformer fed from 6VAC.

Notice that one side of the output winding is tied to +50V DC so that if the called end is answered in the middle of a ring burst, the simulator will stop sending ring current in a very short period. The two line relays RLY2, and RLY4 were needed to totally isolate the high voltage from the rest of the circuit.

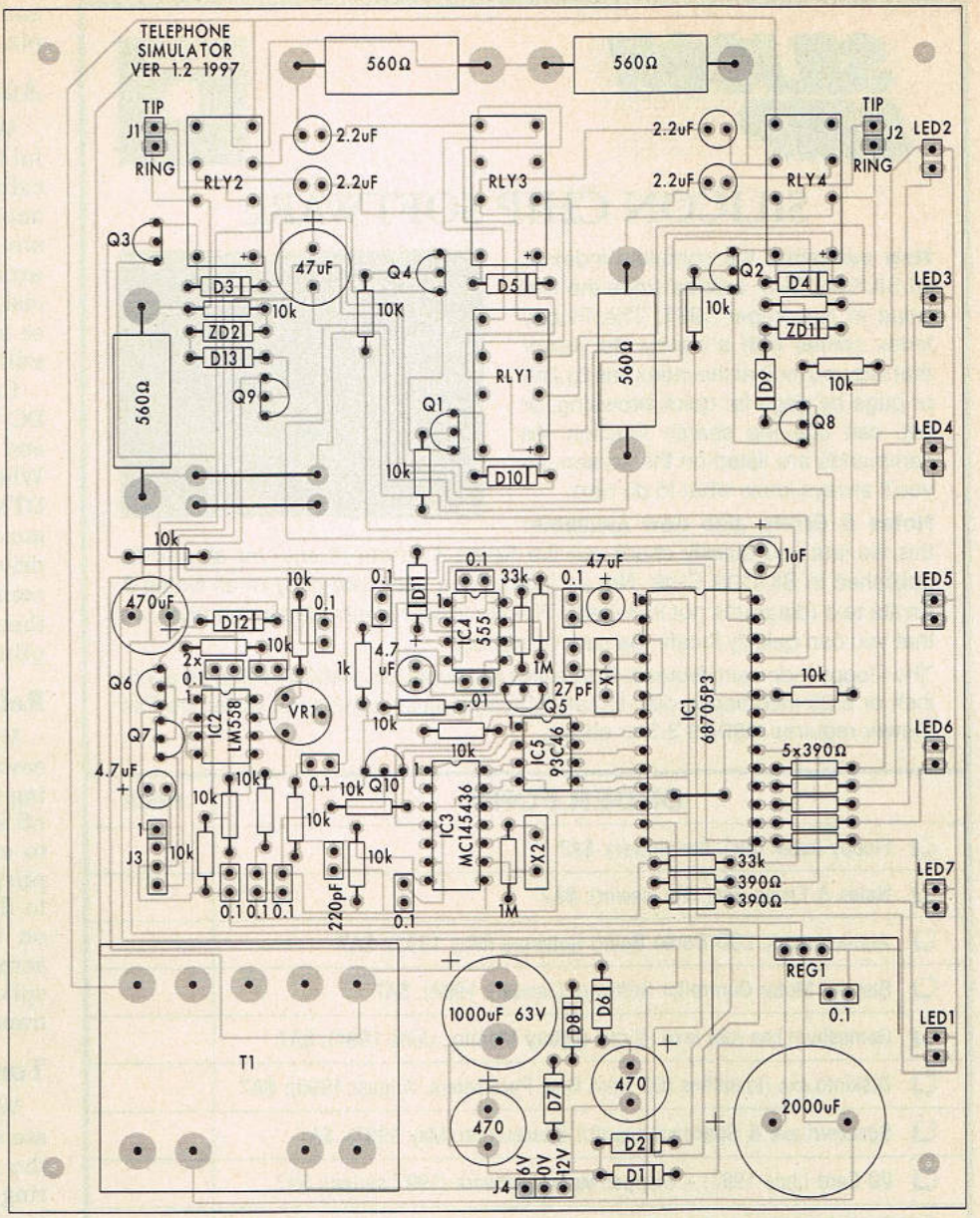


Fig.2: the component layout of the PC board. The LEDs are bent at rightangles to protrude through the front panel.

Watchdog circuitry

The watchdog circuitry is used to prevent the processor from "locking up" and thereby causing the unit to become inoperative. The circuit employs a 555 timer IC4 which is used in an astable mode to reset the processor. If allowed, IC4 would oscillate at a frequency of about 0.25Hz, as set by the values of R18, R26 and C15.

When the processor is running properly, it toggles its EXCHANGE OK port pin every second or so which temporarily turns on transistor Q5 and discharges C15.

While C15 is unable to charge via R18 and R26, the output of the 555 timer stays high, allowing the processor to continue normal operation. If the program were to lock up, Q5 would remain off and allow C15 to charge thus switching pin 3 of the 555 low. The reset line of the processor would now be pulled low via diode D11 and is held low until the 555 changes state. At this point the processor starts again

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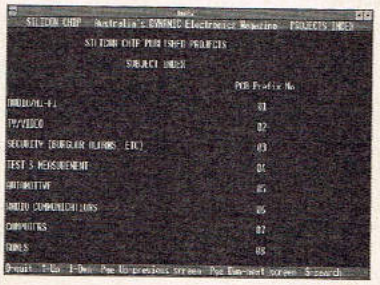

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and continues its pulsing of its port pin.

Audio monitoring

When testing equipment, it is useful to hear what is being sent from the calling end or even from one caller to another. With DTMF dialling, tones are sent from the telephone to the exchange and are decoded by a special chip. If you suspect your telephone or modem is not sending DTMF you will be able to pick it up.

Capacitor C18 is used to provide DC isolation between op amp IC2b and the external telephone circuit. When an AC signal appears (due to DTMF, tones or voice) across C18 they are amplified by IC2b. This op amp drives a complementary output stage consisting of transistors Q6 & Q7 and these drive the loudspeaker via coupling capacitor C28.

Relay driver

Under normal conditions the processor's port pins are low, thereby leaving the relay driver transistors in the off state. When the processor wishes to enable a relay its associated port pin goes high and causes base current to flow to the transistor which turns on to operate the relay. The diode across each relay coil prevents any spikes from damaging the associated transistor when it turns off.

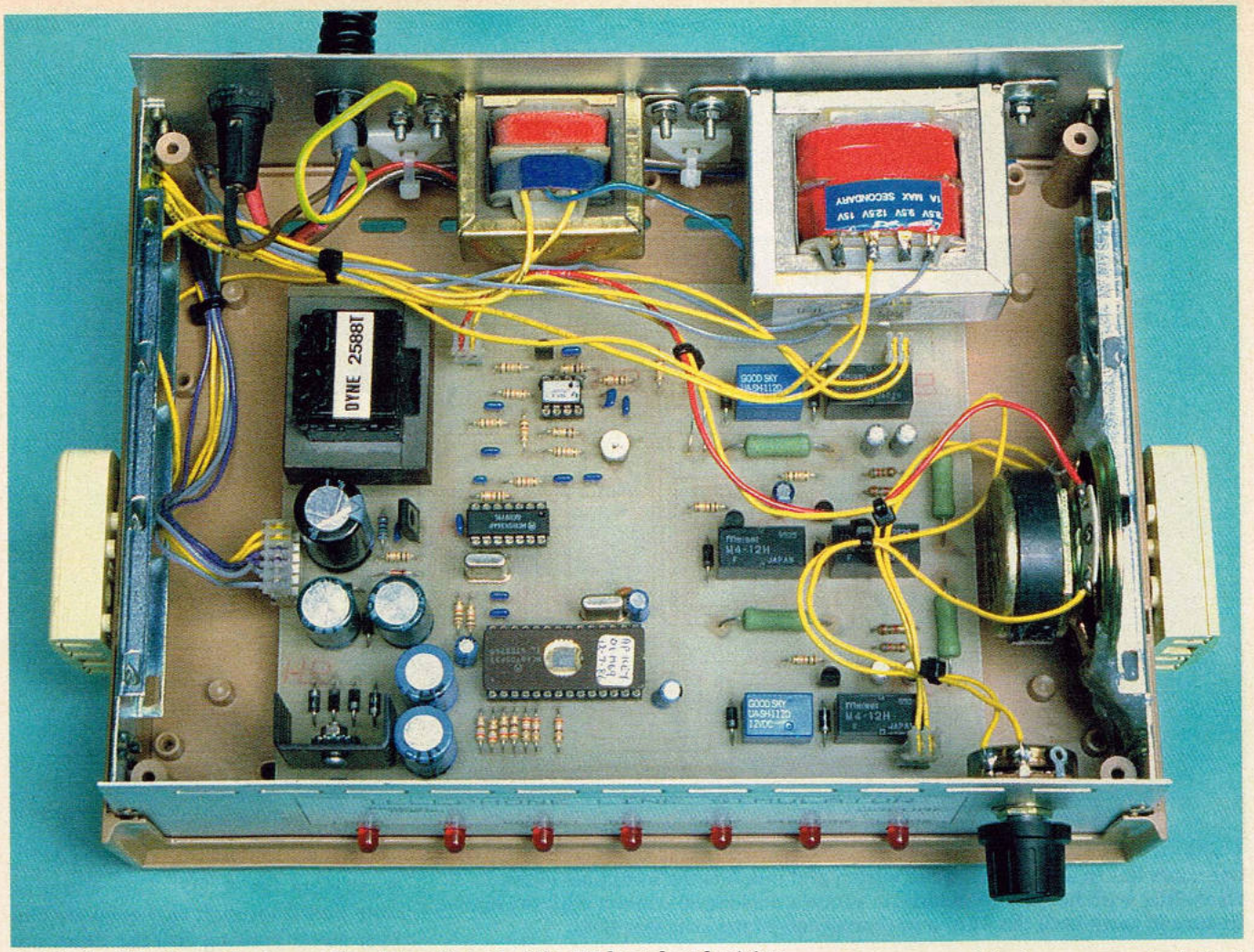
Tone injector

When making a call, certain tones are sent to the calling end to inform the user as to what's happening; eg, ring tone, busy tone or no progress tone (wrong number). The tones are injected in the following way. One port pin is used to try and reproduce all of the tones required. This process comes pretty close to doing what we want.

IC2a is configured as an amplifier with its gain set by trimpot VR1 and resistor R10. The signal waveform from the processors is rounded off by R32 and C6 and it is then coupled by C29 to the op amp which amplifies it and sends it out to line via R13 and C7.

DTMF detection

DTMF (dual tone multi frequency) detection is done using IC3, a Motorola MC145436 tone decoder which receives the incoming tones via a filter network comprising resistors R12 &



Inside the Telephone Exchange Simulator. Note that the PC board and wiring layout of the prototype pictured here has been fairly significantly modified in the final PC board depicted in Fig.2.

R14 and capacitor C11. When a valid tone is detected the DV line (pin 12) of IC3 goes high, signalling to the processor that a digit is being pushed. At this point the processor enables the decoder's output pins by taking the EN line high (pin 3) and reads in the data.

Assembly procedure

Most of the circuitry of the Telephone Exchange Simulator is accommodated on a PC board measuring 161 x 128mm. The components off the board are the power transformer and speaker.

By the way, the prototype shown in the photos has undergone a number of fairly substantial changes so the assembly notes apply only to the circuit of Fig.1 and the PC component layout of Fig.2. Note also that the prototype photos show two power transformers inside the rear panel but the final version uses just one power transformer.

You can begin the PC board assembly by mounting the four standoffs, one on each corner of the board. Next, all of the resistors, links relays, diodes and capacitors can be soldered in. Screw the 7805 regulator to the heatsink with the screw, washer and nut provided and solder this into place. The remainder of the components, with the exception of the ICs can then be mounted.

This done, mount the two telephone sockets and transformer and glue the speaker onto the side of the case with some silastic.

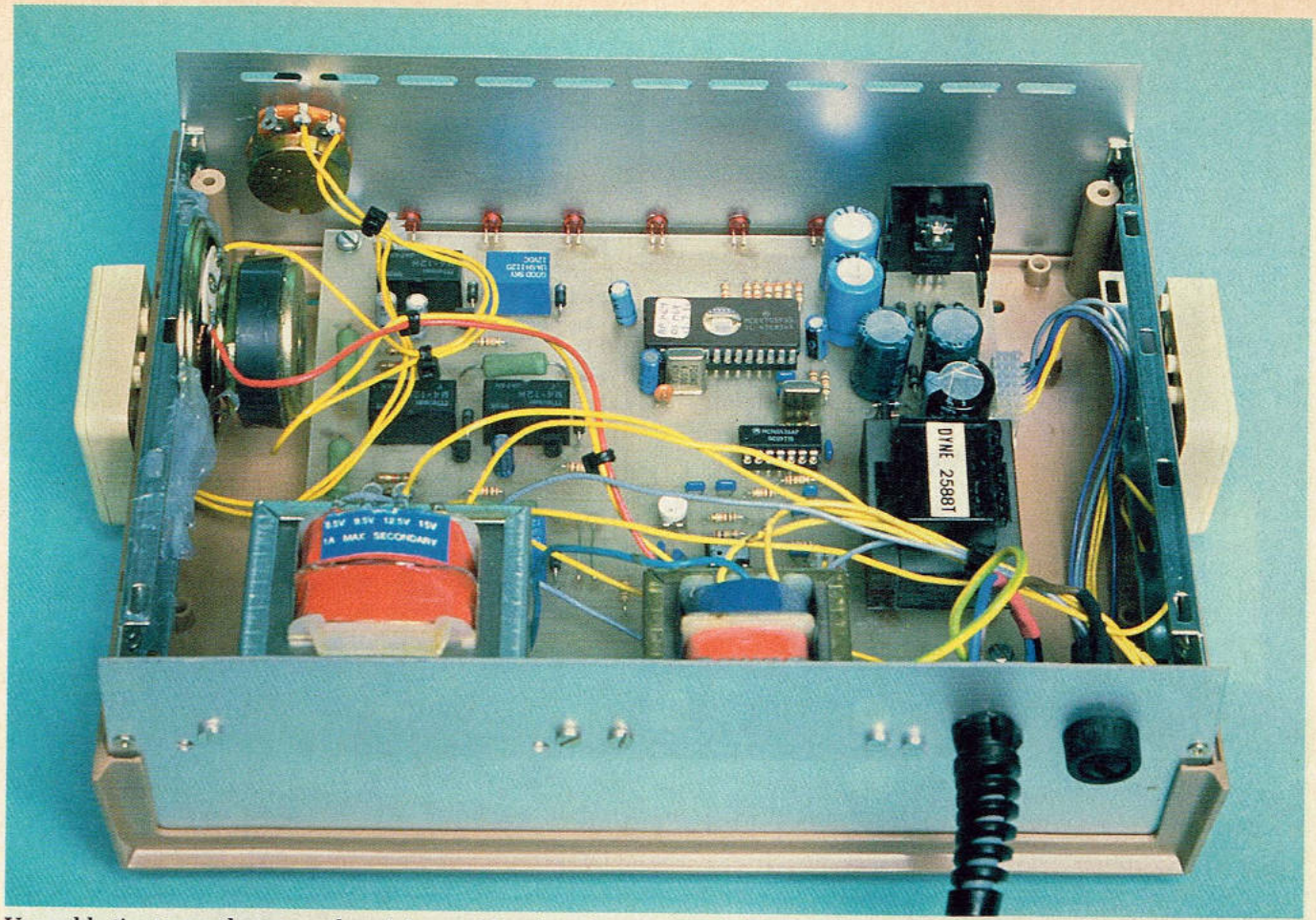
You will need to drill holes for the mains fuse and cordgrip grommet for the mains power cord. The mains wiring can be run, taking care to insulate with heatshrink any exposed terminals. Don't forget to attach the earth wire to a solder lug separately bolted to the case rear panel. **An earth wire should also be run from this point to a solder lug securely bolted to the front panel (not shown on photo of prototype).**

Temporarily connect up the sockets, speaker and transformer with longer pieces of wire to enable you to test the board out of the case.

Testing

Before proceeding, it is well to note that although the ring transformer (T1) looks fairly insignificant, it puts out quite a bite if you get caught across its output. I found this out the hard way!

Without any ICs plugged in, turn on the power and check voltages around the board, especially the supply rails to the processor. If all is OK, turn off the power and plug in the ICs. Turn on the power again and use a small screwdriver to short out the TIP and RING connectors of each telephone line in turn. Each time you do so, the LOOP LED for that line should come on.



Use cable ties to neatly secure the wiring and insulate the terminals of the fuseholder with heatshrink tubing, to prevent accidental contact with the mains. Be sure to earth both the front and rear panels of the case (see text).

Plug a phone in at each end and lift one of the receivers. Listen for dial tone and use trimpot VR1 to set the tone to the desired level. If the tone level is too high, you may swamp the DTMF from the phone, causing the Exchange to miss any dialled digits.

Also at this time use the volume control (VR2) on the front panel to set the volume coming out of the speaker. With the receiver off hook, hit some of the keys on the telephone and listen for tones through the speaker. If all seems well, you can shorten the wires and solder them to the posts. If you have connectors that are spaced at 0.1 inch you can use these instead of hard wiring.

Storing a telephone number

As this is a two-line telephone exchange simulator we need a telephone number for each end. These are stored in the serially fed EEPROM, IC5. Pick up one end and wait for dial tone. Hit *6805 and wait for two beeps before dialling in your telephone number of up to 20 digits in length. When this is done, hit the # button to terminate and wait for two beeps. You have now programmed that extension with its own number. Do the same for the other end and yes, you are allowed to have the same number at both ends.

Detailed talk-through

For this procedure we'll assume a phone is plugged in at each end.

Lift the handset for line one. This causes a voltage of more than 12V to appear across the line loop detectors, thus signalling the processor.

The exchange now realises that you want to make a call so it switches RLY1 over and starts injecting Dial tone out through its port pin, through op amp IC2a where it is amplified, through RLY1, through C1 and out to the line.

At the same time, the tone is also fed to op amp IC2b via C18 and R27 where it is amplified and buffered by transistors Q6 & Q7. This audio is now heard through the speaker. The user starts dialling and the tones are passed by C1 back through RLY1, through C10 and the filter network to the DTMF decoder, IC3. Once a tone pair has been recognised, DV (pin 12) on the MC145436 goes high, signalling to the processor to get the data in. The digit is retrieved and stored until the whole number is complete or until it gets a wrong digit, at which time the "No progress" tone is sent back to the caller.

Once the correct number has been loaded, the exchange starts toggling RLY4, causing bursts of ring current to be fed out to line. Also ring tone is sent back to the user to indicate what is happening. If the second phone is answered, the line loop detector signals to the processor to stop sending ring current and RLY4 remains in its normal state.

The ring tone is stopped and RLY3 operates, causing a speech path to be established. The call is now complete. During the progress of the call the LEDS on the front panel will be operating to indicate the progress. **SC**

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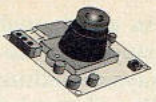

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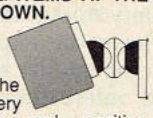

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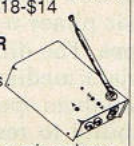

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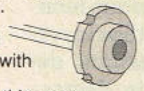

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USA made wands. Sapphire tip, curly cord & 5pin DIN plug. converts bar codes to a digital pulses, 0.19mm spot size is. Open collector output TTL / CMOS compatible needs 5V supply. $45

MOTOR PROTECTORS / MONITORS:
suits 3 phase motors up to 1000V / 1000A shows thermal, mechanical & electrical fault conditions, can be used as a shearpin, consists of motor protection unit built in current transformers (wires pass through, no connection physical motor wires), A 3m cable links it to a monitor with a 6 digit LCD,in- dustial quality, made in Holland, new, at a fraction of new cost: $200 for the pair.

MAGNIFIERS / LOUPES
jewellers eye- piece with a plastic lens: $3,... 50mm $8, 75mm $12,... 110mm $15. SPECIAL: The set of four for $25.

***********KIT OF THE MONTH************
It is difficult for us to coordinate advertising of kits in the two mags (one of which your reading now). Check our Web Site in week two of each month to see which new kits we will release that month.

OATLEY ELECTRONICS
PO Box 89 Oatley NSW 2223
Ph (02) 9584 3563 Fax 9584 3561
orders by e-mail: oatley@world.net
http://www.ozemail.com.au/~oatley
major cards with ph. & fax orders,
Post & Pack typically $6

MAILBAG

AST Notebooks have 3-year warranty

I have just read the Serviceman's Log: "Encounters With A Notebook PC", from the December 1997 issue. I repair and service AST and NEC laptops at work and was a bit surprised at what happened and the time wasted repairing the Notebook.

In general, AST and NEC Notebooks have a 3-year warranty and even if the notebook is out of warranty, there are parts available new or "rotate" (repaired parts that are swapped out at a lower cost). Most repairs for AST Notebooks can be done in a few days, depending on parts in stock.

For a simple phone call to AST, the repair may have been done under warranty and the job may have been done in about half an hour plus time to get the part but there again, some of the customers do not know how long the warranty period is.

S. Reynolds.
(No address supplied).

Kelvin not degrees

With regards to the story on lighting in the December 1997 issue of SILICON CHIP, the author made numerous mentions of temperature. The author incorrectly, on a number of occasions, described temperature being in degrees Kelvin. This should be only Kelvin, not degrees Kelvin. Kelvin is a measurement of absolute temperature – it is not degrees at all.

A. Miles,
Bayswater, Vic.

TENS electrodes available cheaply

I have been buying SILICON CHIP since its "birth". In the Mailbag (November 1997) I came across a letter from J. Cowan, regarding the availability of the TENS electrodes. It is true that they are hard to get. But the price – from the indicated supplier – is rather steep. Since I am now a major designer and manufacturer of health related electronic equipment, I buy these pads in bulk so I know their true cost. (I supply them with several of my products).

Perhaps you could let your readers know that I can supply these pads for $8.00 a pair, plus $2.00 postage and handling. I can also supply the leads, red and black, with 2mm plugs on one end and 4mm banana plugs on the other, $7.00 a pair. (I don't like using phone jacks; they are unreliable).

Les Banki, Water Fuel,
18 Springfield Rd,
Springvale, Vic 3172.

Copyright must be preserved on CDs

Your December 1997 editorial on the subject of compact discs sharply demonstrates your lack of knowledge of the proposed legislation changes and of the mechanics of the music industry. Yes, I am pushing a barrow. I have been involved in the music industry for ten years, as a performer, recording engineer and technician. I have also had dealings with five different recording companies (local and international) and am a member of the Australian Performing Rights Association (APRA). Now you can easily dismiss me as biased, but I'll keep writing anyway. Now to your comments.

$30 is too much for an audio CD while CD-ROMs are almost given away, true (especially since the wholesale price of a CD from a major company is only $20). The difference between the two is that the free CD-ROMs are full of shareware; that is, you only get a limited version of the software and are expected to send off a registration fee if you want to use all the features of the program.

The equivalent in musical terms would be if you could give away a CD that only plays the first 20 seconds of each piece of music until you enter your serial number. Have you noticed that a top-of-the-line CD-ROM costs from $50 to $80 (or more if you're buying serious software)? The point is, you're not paying for the price of plastic, you're paying for the software on it, be it data or music.

Companies like Naxos can produce cheap CDs but look at their list of composers. Decomposers is probably more accurate, as they have all been dead for at least fifty years, so Naxos, Harmonia Mundi, et al, don't have to worry about paying royalties. As their releases are classical, which unlike popular music is a small but stable market, they have few dud releases; they don't have high profile advertising, minimal sleeve artwork costs and the musicians involved don't feel they have to spend three months in a hideously expensive recording studio just so they can sound decent (says something about the average quality of musicianship, doesn't it?).

The price of blank CDs is amazingly low for any storage medium, true. And if you have the expertise to put together a top quality recording of original and interesting music, then go ahead, good luck to you. I suspect, however, that like most people, you are not capable of writing music, or playing all the instruments (or programming, if you like samples), or producing a crisp, pleasing recording.

Blank CDs certainly are being used for music piracy but so are Digital Audio Tapes. The difference is the price of the blank medium. DAT blanks have a levy on them specifically because of their ability to render perfect digital copies; no such levy exists on blank CDs.

You can buy cheap records overseas but only in parts of the world where copyright doesn't exist (you know copyright; it's that thing that stops your competitor copying your design and passing it off as their own. Electronic engineers may think they are the only people who deserve to have their work protected but the rest of us have some rights).

The Government's plan is to remove the notion of intellectual property from music. If that happens, there would be nothing to stop a record company taking a tape to a different country, pressing 100,000 discs, claiming the record didn't sell, declaring the stock "deleted" (written off as a loss on their local tax), then shipping the entire stock to this country to be sold at whatever price the record company sees fit. Their costs are paid (excluding shipping), they don't have to pay the artist, and they are free to sell the discs, underselling local musicians.

This would be very good for the major labels but very bad for the musicians like myself who only receive royalties. Incidentally, the royalties I receive for each full length album I sell is 1/18th of the sales tax... "if five percent appears to small/be thankful I don't take it all"? (ack. to Lennon/McCartney).

Internet sales of music already exist. For example, there are two different

websites offering bootleg recordings of my group's live performances ("Trout Fishing in Quebec"). I wrote the music, I performed it, but am I rewarded for the continued sales of that performance? Do I even have a say in whether I want that recording released? No, they are pirate recordings. The Government simply wants to legitimise this kind of piracy, to let the international companies behave in exactly the same manner.

To summarise, I do believe that CDs are too expensive. Some of us in the music industry are trying to work out ways of bringing down the prices but the hack and slash approach of removing copyright protection will simply discourage musicians from recording, forcing the already cash strapped studios in this country out of business and ensuring that the only stock on the shelves will be of foreign manufacture. (Australia is a signatory to the international convention on intellectual property rights, so there is a question of whether such legislation is legal.)

T. Newsom, Sydney.

Comment: we have not suggested that copyright on CDs should be waived. Given that copyright fees are such a small proportion of the retail price of CDs, we see no reason why CD prices can not be reduced markedly while still maintaining copyright fees to the composers.

No problem with Millennium bug

I read with interest your editorial in the January 1998 issue and, like you, I wonder how much of the hype is due to the old snake oil salesman element in the computer industry.

Everywhere you turn these days one finds people telling you to set the time and date on your PC to a few minutes before midnight on December 31, 1999, turn the computer off and turn it back on again a few minutes later and check the time and date to see if the PC is year-2000 compatible. I would suggest that this may not give the full story.

I own a 486/66 and I decided to cold boot the computer and run Setup. I then set the time and date to just before midnight December 31, 1999 and watched what happened in real time. In my case, the PC jumped back to January 1980. If I had gone no further I would have been left with the opinion that my PC would not cope with the next century. However, while still running Setup, I manually entered the year 2000 which it was quite happy to accept.

I saved the changes and rebooted the computer and when I checked the time and date at the "C" prompt it correctly showed January 1, 2000. I opened MSWord and it also was quite happy with the new date. When tested, the computer was also quite happy to go from one day to next in the year 2000.

It would seem, therefore, that the only year 2000 problem I have is that if I still have this PC in the next century, I will have to tell it manually when January 1, 2000 arrives. Like yourself, maybe I am missing something here but I think not.

E. Barton,
Lower Templestowe, Vic.

Millennium bug is a big problem

I refer to your editorial in the January 1998 issue. It seems that, like most users of computers these days, you've adopted the notion that the term computer is exclusively synonymous with the term PC. In fact, an enormous amount of data processing is still done using relatively ancient software, on machines either nearly as ancient or on ones designed as drop-in replacements for them.

Much of our banking and credit card processing is done this way. Possibly the most notorious example of this is the aircraft control systems used at many of the major US airports. They still use 1960s vintage Sperry computers (direct descendants of the original UNIVAC machines), because nobody can figure out how to replace them without shutting down the entire US air transportation system!

You imply that the millennium bug would probably apply mostly to "some old COBOL-based accountancy and other software". In fact, many large financial institutions typically depend on huge "suites" of thousands of programs, all written in COBOL, many dating back to the 1960s! True, PCs are widely used in a "front end" sense for the actual data input but the occasional bug on an isolated user's machine isn't likely to gum up the works too much.

The plain fact is that it's sometimes literally taken decades to get the software running reliably and there's no reason to think something written in a newer language is going to "settle down" any more quickly. Thus they have an enormous incentive to keep the old reliable software going. You've only got to look at the employment ads in the computer section of Tuesday's "Australian". There's still plenty of work for COBOL programmers.

As far as the millennium bug goes (it would be more accurately described as the "century bug"), the problem is very real. It's not just a matter of people getting ridiculous numbers on their insurance renewals, either. A major source of potential disaster lies in the way storage space is set aside for variables in COBOL. The default numeric data type is the unsigned integer, which can hold only positive, whole numbers.

To save precious memory, in the early days programmers used unsigned integers whenever they could since they only required a single six-bit word for each digit. In most cases they would have specified a two-digit unsigned integer for year calculations, since they wouldn't have imagined the software would still be in use a century from now!

Unfortunately, when the year clocks over to the dreaded "00" the computer will start trying to assign negative numbers to these unsigned integers and the system will come to a screeching halt, displaying the dreaded "ABEND" (Abnormal End) error message. When that happens there's nothing you can do except call in a programmer to fix the problem. At the moment the software companies are employing thousands of programmers, many in the third world, to scan the millions of lines of source code looking for such traps.

Another big problem is that most of these programs have been subject to countless undocumented kludges and "2am quick fixes" to overcome unforeseen problems that may only come up once every year or so. So it's not simply a matter of resetting the date and running some sample data to see what happens – the problem may not rear its ugly head for months!

K. Walters,
Schofields, NSW.

Part 2: the Command Station

Last month we introduced the concept of Command Control which enables as many as 16 locomotives to run on a layout with simple wiring. This month we describe the heart of the system – the Command Station.

The Command Station is the brains of the Protopower 16 System. It powers the handheld throttles, interprets their commands and encodes the throttle information onto the correct channel of the serial data stream. Most importantly, the Command Station drives the Power Station and this feeds the power and the serial data stream to the track.

In effect, the Command Station modulates a DC power supply (the Power Station) so that the 5.2V serial data signal is superimposed on top of a constant DC to form a composite track voltage of about 16V DC. This track voltage is constant over the entire layout.

To understand the operation of the Command Station we need to refer to the block diagram of Fig.1. This looks unrecognisable to any model railway buff but don't worry as it will all be explained. We will start with the master clock. Because the Protopower 16 must provide a stable serial data stream it needs a crystal oscillator timebase and this is the master clock. It controls the timing of all functions in the Command Station.

Run your model railway with COMMAND

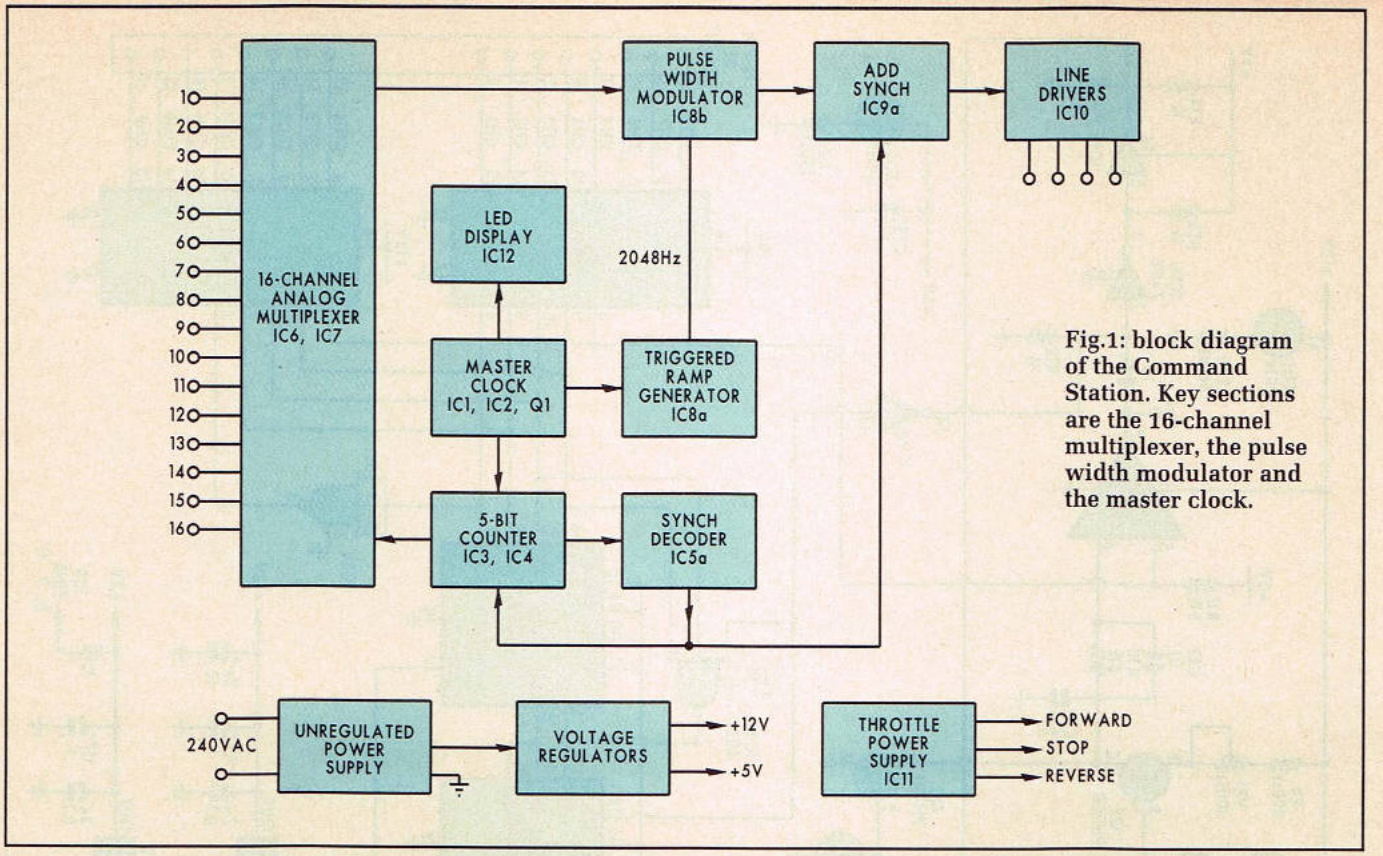


Fig.1: block diagram of the Command Station. Key sections are the 16-channel multiplexer, the pulse width modulator and the master clock.

The LED display consists of four LEDs which flash at a slow rate to give an indication that the master clock is working.

The master clock drives two circuit blocks, a 5-bit counter and a triggered ramp generator which we'll come to in a moment.

The 5-bit counter has a number of functions. First, it controls the 16-channel analog multiplexer. That is a mouthful but it can be thought of simply as a single pole 16-position switch which is being continuously rotated. The multiplexer accepts the signals from each of the 16 handheld throttles and feeds them through, one at a time, to the pulse width modulator.

Secondly, the 5-bit counter drives the synch decoder. If you refer back to Fig.2 on page 32 of last month's article, you will see that the serial data stream consists of 16 pulses followed by a synch pause, followed by another 16 pulses and so on. Well, the 5-bit counter generates the pulse stream and the synch decoder generates the synch pause.

Going back to the master clock, we noted that it also drives the triggered ramp generator. The ramp signal from this is fed to the pulse width modulator (IC8b) which compares the selected DC signal from the multiplexer with the ramp signal. The result is a variable width pulse corresponding to the throttle signal for each channel.

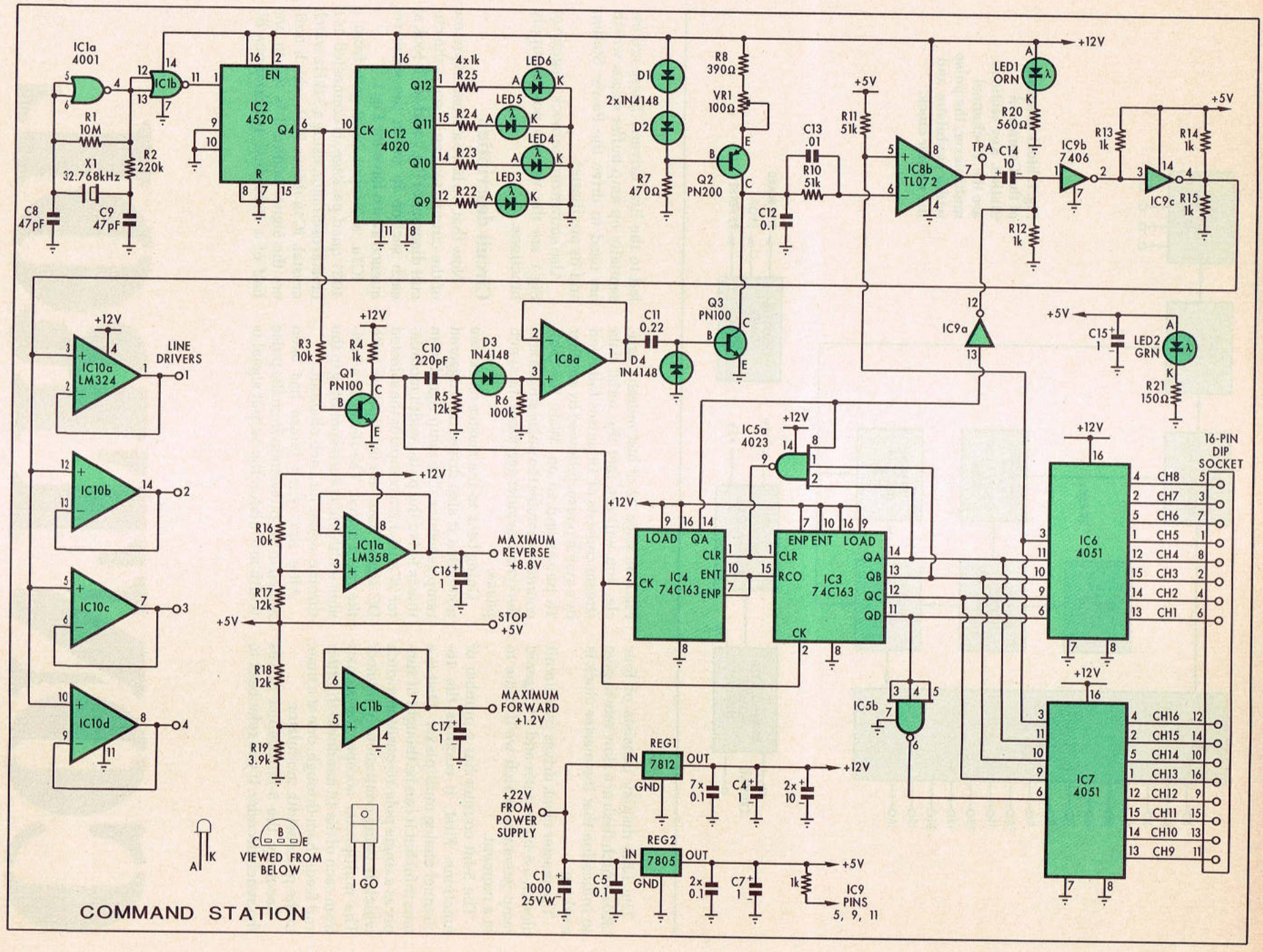
After the synch pause has been added to the pulse train from the pulse width modulator, the output signal is fed to the line drivers. These are essentially op amp buffer stages which are used to drive the Power Station and its auxiliaries.

Also shown on the block diagram of Fig.1 are the various power supply functions.

Circuit description

Now that we have a broad overview of the circuit, we can discuss the circuit diagram of Fig.2 and we'll look at each section in much the same sequence as we have for Fig.1.

IC1a, a 2-input NOR gate from a 4001 quad package, is connected as a crystal oscillator, using a 32kHz watch crystal. IC1a drives IC1b which buffers the signal before it is fed to one half of a 4520 dual synchronous bi-



COMMAND STATION

Fig.2: this circuit accepts the signals from up to 16 handheld throttles and encodes a serial data stream with bursts of 16 width modulated pulses.

nary counter. The output is taken from pin 6 and is a square wave with a frequency of 2048Hz.

The 2048Hz signal is fed to IC12, a 4020 14-stage counter which drives four LEDs. This counter divides the 2048Hz signal by 512, 1024, 2048 and 4096 and the LEDs then flash on and off for periods of 1/8, 1/4, 1/2 and 1 second respectively. Actually, this part of the circuit is a bit of a gimmick and could be omitted, if you want.

The 2048Hz signal is also fed to the base of transistor Q1 which buffers the signal to provide the master clock.

5-bit counter

Pulses from the master clock, Q1, are fed to two 4-bit 74C163 synchronous binary counters, IC3 & IC4. They are cascaded together to create a 5-bit counter with the ripple carry of IC3 (pin 15) connected to pins 7 & 10 (enable P and enable T) of IC4.

Outputs QA, QB, QC and QD (four bits) are taken from pins 14, 13, 12 & 11 of IC3 and used to control two 4051 8-channel multiplexers (IC6 & IC7) which together form the 16-channel multiplexer depicted in Fig.1. Pin 3 of both 4051s is commoned, to form the output of this 16-way switch.

Synch decoder

Now the question is, if we only need 4-bits from the counter to control the 16-channel multiplexer, why do we need a 5-bit counter? Isn't the second 74C163, IC4, unnecessary?

We do need IC4, for the following reasons. In our Protopower 16 application, we need to count to 16, pause and then repeat the count sequence, where the "pause" period acts as a means of synchronising the pulse train. This is achieved by detecting a count of 19. Outputs QA & QB of IC3 (pins 14 & 13) are fed to NAND gate IC5a, along with QA, pin 14 (QE?), of IC4 (ie, 1+2+16=19) to detect the 19th count. The output from IC5a (pin 9) is then used to clear both counters to zero.

From the pulse timing diagram of Fig.3 it can be seen that QA of IC4 (QE) acts as a synchronising pulse as it occurs between clock pulse 16 and clock pulse 20 and has a duration of four clock pulses. It separates each burst of 16 pulses.

Triggered ramp generator

We now come to the heart of the circuit which constitutes the triggered ramp generator and the pulse width modulator, both based on IC8, a TL072 dual FET-input op amp.

Clock pulses from the collector of Q1 are coupled to a differentiating network consisting of the 220pF capacitor C10 and 12kΩ resistor R5. The differentiator generates positive-going spikes at the leading edges of the clock pulse and negative-going for the trailing edges. Diode D3 passes the positive-going spike and blocks the negative-going, to drive op amp IC8a, which is connected as a voltage-follower. Basically, it just acts as a low-impedance buffer.

IC8a's output is AC-coupled via capacitor C11 to the base of transistor Q3. Each time a positive spike is fed through to Q3, it turns on to discharge capacitor C12 at its collector. In between each discharge, this capacitor is charged from the constant current source comprising transistor Q2 and the two diodes at its base. By using a constant current source to charge capacitor C12, we obtain a linear ramp waveform.

Pulse width modulator

Op amp IC8b is connected as a comparator to become the pulse width modulator. The inverting input, pin 6, is fed with the triggered linear voltage ramp, while the non-inverting input, pin 5, is fed in turn with the signal voltages from the 16-channel multiplexer (IC6 & IC7).

Remember that the multiplexer sequentially switches 16 voltages, each representing one handheld throttle. Therefore as each of the 16 throttle voltages is compared with its corresponding linear ramp voltage, the width of the resulting output pulse will be varied accordingly.

The output of IC8b is AC-coupled by C14 to IC9b, a 7406 open-collector inverter. However, readers will note that in our serial string of 20 pulses, there are 16 which enable the multiplexer and four pulses which represent the synch pause and these latter four must be blanked out.

This is achieved as follows. The

Parts List for Command Station

1 PC board, 162 x 101mm, code 09102981
1 10-way PC-mount insulated terminal block
1 16-pin header
1 16-pin IC socket
1 32.768kHz watch crystal
1 100Ω trimpot (VR1, Bourns 3386 or equivalent)

Semiconductors
1 4001 quad 2-input NOR gate (IC1)
1 4520 dual synchronous counter (IC2)
2 74C163 or 4163 binary counter (IC3, IC4)
1 4023 triple 3-input NAND gate (IC5)
2 4051 1-of-8 multiplexers (IC6, IC7)
1 TL072 dual FET-input op amp (IC8)
1 7406 hex inverter with open collector outputs (IC9)
1 LM324 quad op amp (IC10)
1 LM358 dual op amp (IC11)
1 4020 14-stage binary counter (IC12)
2 PN100 NPN transistors (Q1,Q3)
1 PN200 PNP transistor (Q2)
4 1N4148, 1N914 small signal diodes (D1,D2,D3,D4)
1 orange LED (LED1)
1 green LED (LED2)
4 red LEDs (LED3-LED6)
1 7812 12V 3-terminal regulator (REG1)
1 7805 5V 3-terminal regulator (REG2)

Capacitors
1 1000µF 25VW electrolytic
3 10µF 16VW electrolytic
5 1µF tantalum or PC electrolytic
1 0.22µF MKT polyester
11 0.1µF monolithic or MKT polyester
1 .01µF MKT polyester
1 220pF ceramic
2 47pF NPO ceramic

Resistors (0.25W, 1%)

1 10MΩ	1 3.9kΩ
1 220kΩ	9 1kΩ
1 100kΩ	1 560Ω
2 51kΩ	1 470Ω
3 12kΩ	1 390Ω
2 10kΩ	1 150Ω

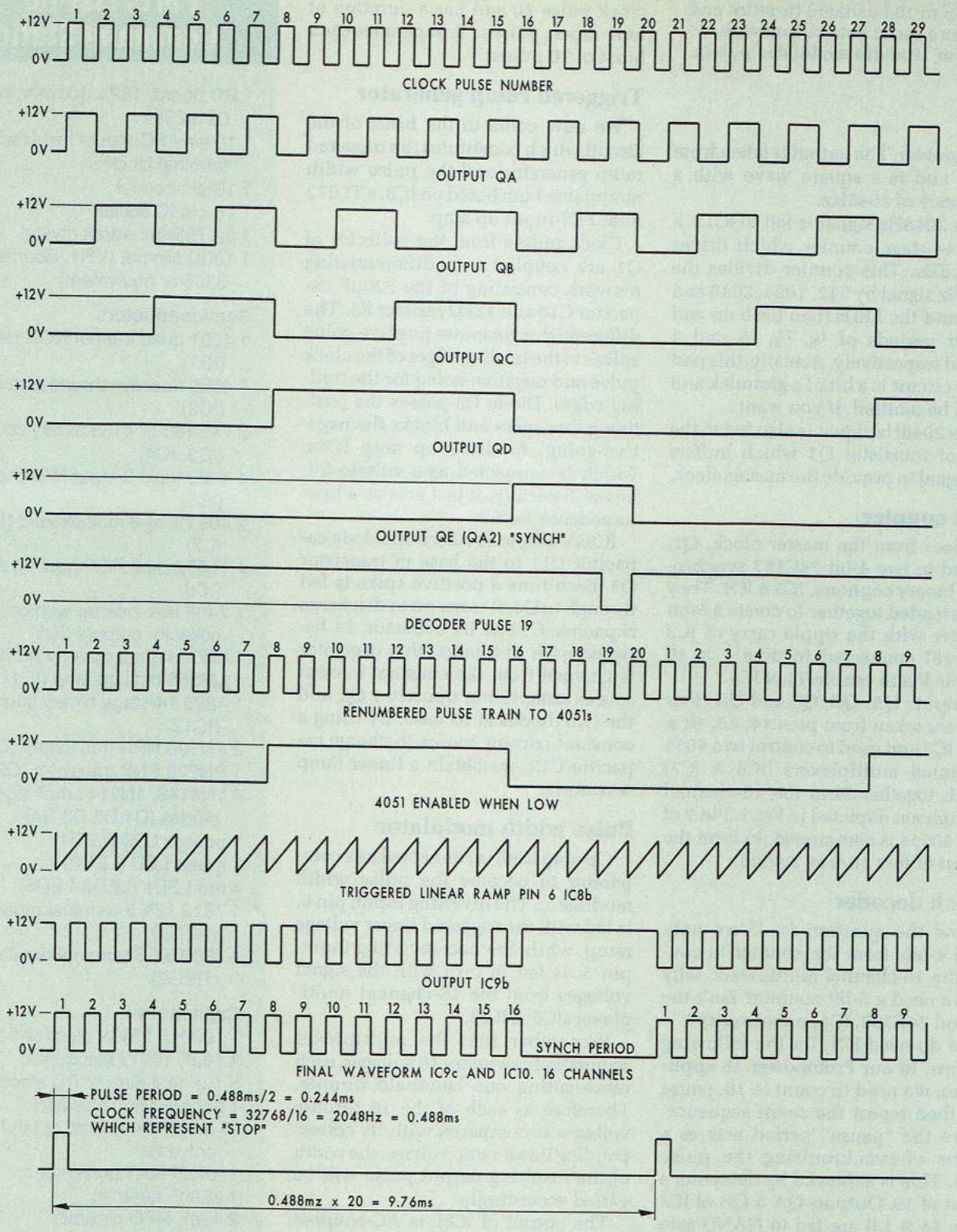

+12V
0V
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
CLOCK PULSE NUMBER
OUTPUT QA
OUTPUT QB
OUTPUT QC
OUTPUT QD
OUTPUT QE (QA2) "SYNCH"
DECODER PULSE 19
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 1 2 3 4 5 6 7 8 9
RENUMBERED PULSE TRAIN TO 4051s
4051 ENABLED WHEN LOW
TRIGGERED LINEAR RAMP PIN 6 IC8b
OUTPUT IC9b
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
SYNCH PERIOD
1 2 3 4 5 6 7 8 9
FINAL WAVEFORM IC9c AND IC10. 16 CHANNELS
PULSE PERIOD = 0.488ms/2 = 0.244ms
CLOCK FREQUENCY = 32768/16 = 2048Hz = 0.488ms
WHICH REPRESENT "STOP"
0.488mz x 20 = 9.76ms

Fig.3: this is the timing diagram for the circuit of Fig.2.

synchronising pulse is taken from the 5-bit counter via IC9a. Because IC9a has an open-collector output but no external pull-up resistor, it effectively works as a switch to shunt any signal at its output to ground when its input is high. In effect, synchronising has been added to the pulse train by IC9a.

The resultant signal is inverted by IC9b which also performs a level translation to give a 5V peak-peak amplitude. This signal is inverted again by

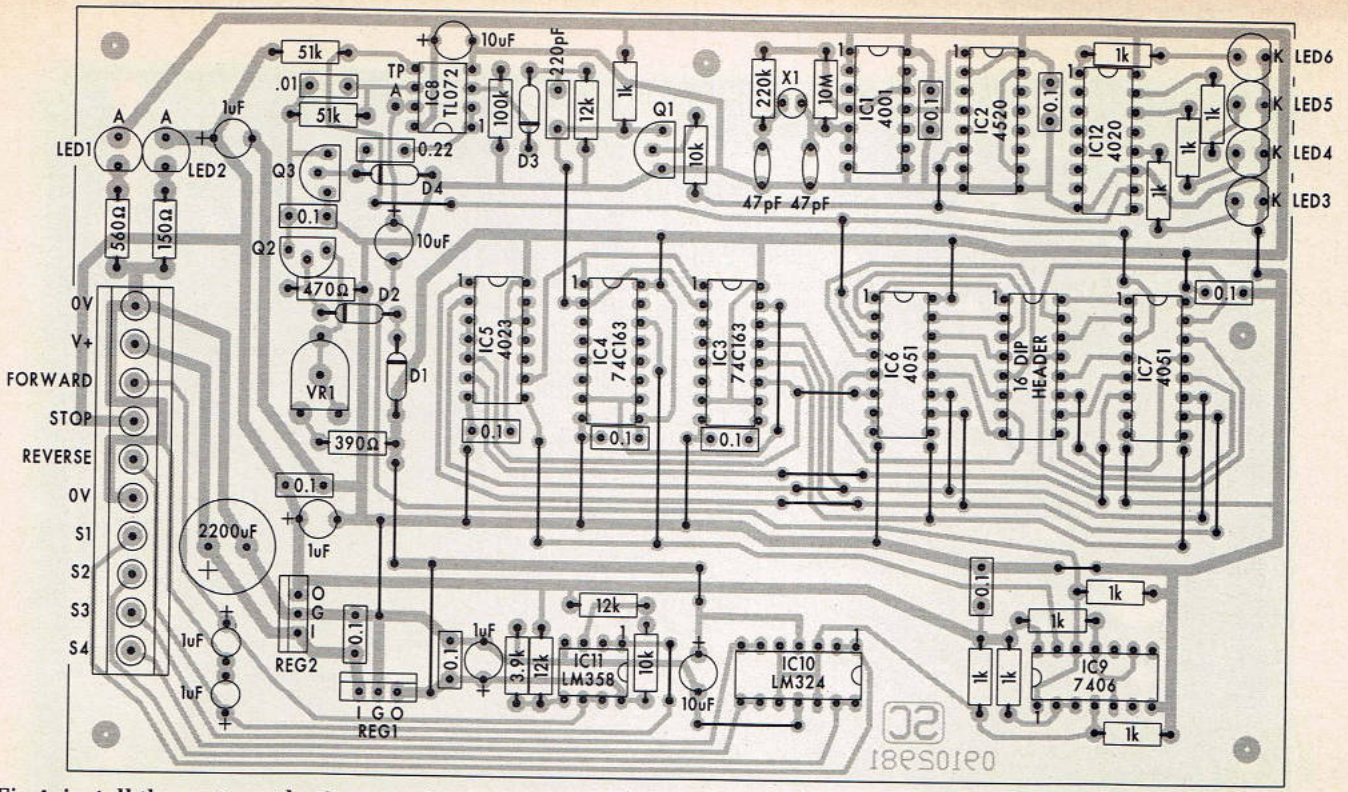


Fig.4: install the parts on the Command Station PC board as shown in this wiring diagram, starting with the smaller components and working up to the larger parts. Make sure that all polarised parts are correctly oriented.

IC9c and its output is effectively halved by a voltage divider consisting of resistors R14 & R15. The signal is fed to IC10.

Line drivers

IC10, an LM324 quad op amp, is set up as four identical voltage followers. Their outputs are used to drive either the Power Station or an Auxiliary Power Station, which supply power to the track.

Two op amps on the circuit remain to be discussed. They are in IC11, an LM358 dual op amp (these are virtually the same op amps as in the LM324). IC11a & IC11b are connected as voltage followers in such a way as to provide three output voltages, +8.8V, +5V and +1.2V. These voltages are fed to the handheld throttles. The +5V actually comes from the 5V 3-terminal regulator REG2 while the other voltages come from resistive voltage dividers connected across the +12V and +5V supply rails.

Using this system, only five wires are needed to connect each hand throttle. The hand throttles will be discussed later in this series of articles.

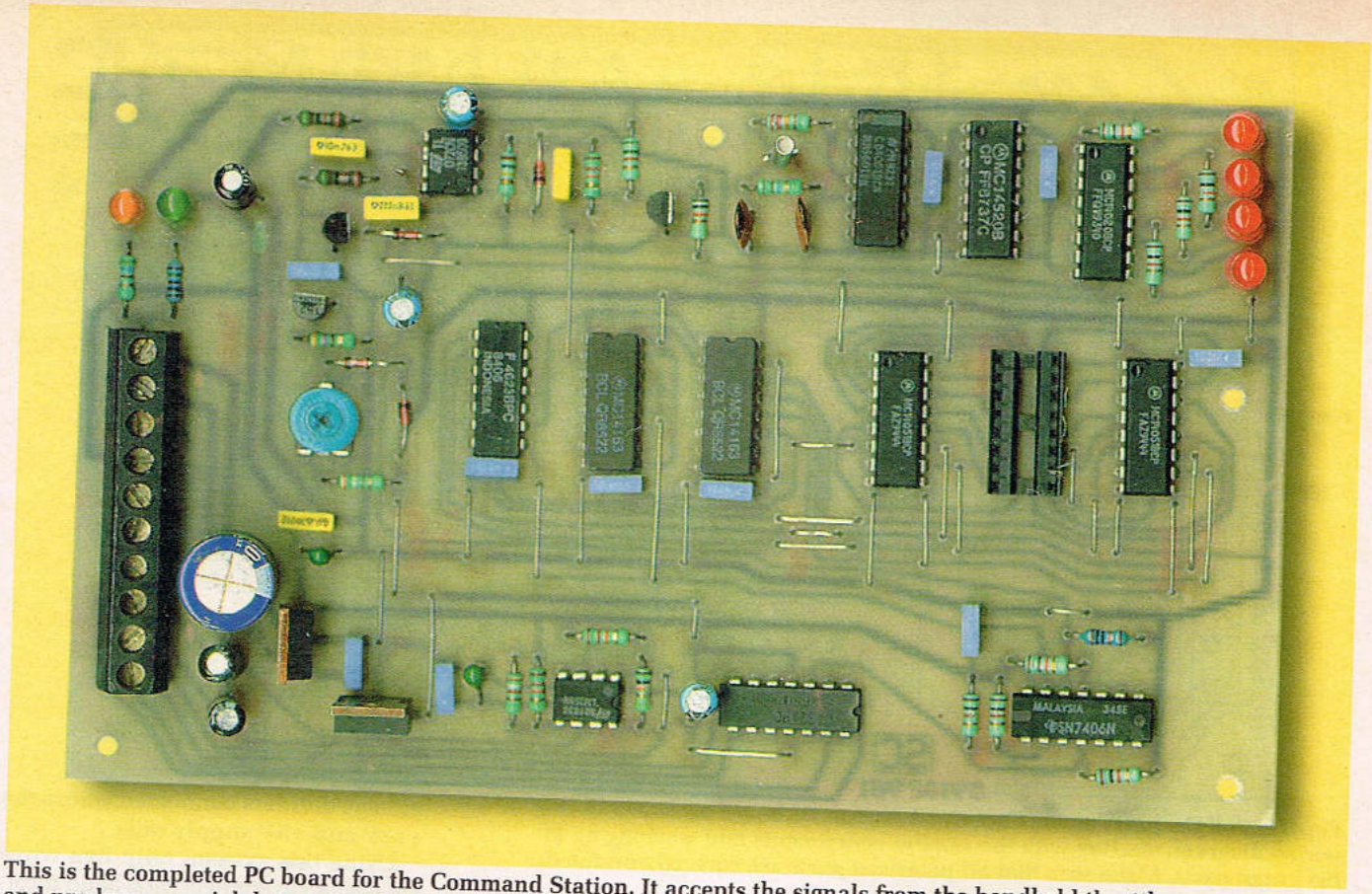
Finally, there are two 3-terminal regulators, to provide the +5V and +12V supply rails. This completes the circuit description. Let's now discuss the construction of the Command Station.

PC board assembly

All the components, with the exception of the power transformer and

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10MΩ	brown black blue brown	brown black black green brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	51kΩ	green brown orange brown	green brown black red brown
❑	3	12kΩ	brown red orange brown	brown red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	1	3.9kΩ	orange white red brown	orange white black brown brown
❑	9	1kΩ	brown black red brown	brown black black brown brown
❑	1	560Ω	green blue brown brown	green blue black black brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	390Ω	orange white brown brown	orange white black black brown
❑	1	150Ω	brown green brown brown	brown green black black brown



This is the completed PC board for the Command Station. It accepts the signals from the handheld throttles and produces a serial data stream which is superimposed on the supply voltage to the model railway track layout. Note that the final version differs slightly from this prototype board.

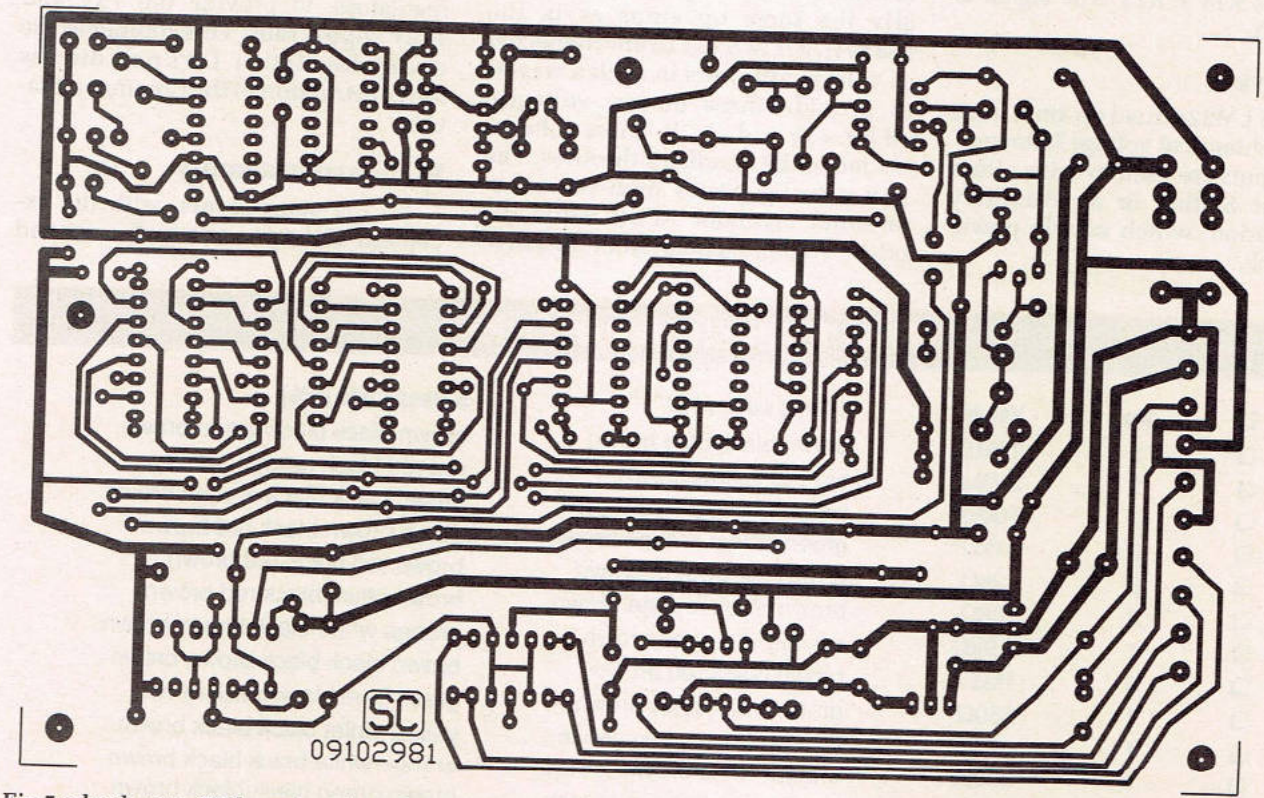


Fig.5: check your PC board against this full-size etching pattern before installing any of the parts.

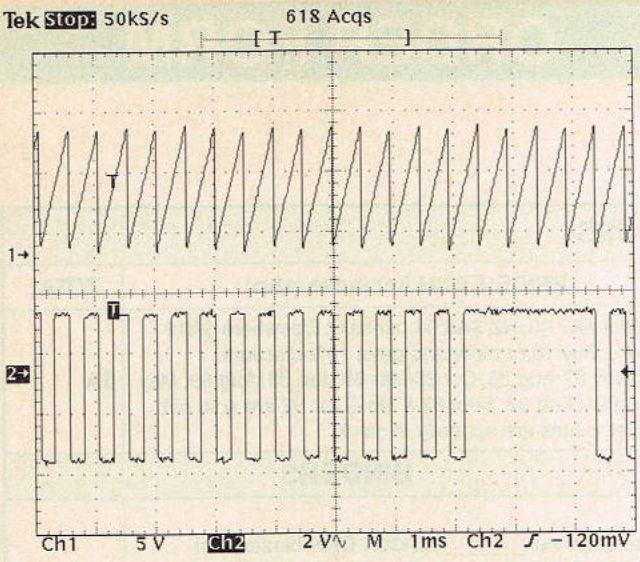


Fig.6: these scope waveforms show the triggered linear ramp waveform at pin 6 of IC8b (top trace) and the 16-pulse burst and sync pause at pin 2 of IC9b (lower trace). The ramp waveform has a frequency of 2048Hz, as controlled by the master clock. The waveform on pin 2 of IC9b is fed to the line drivers in IC10.

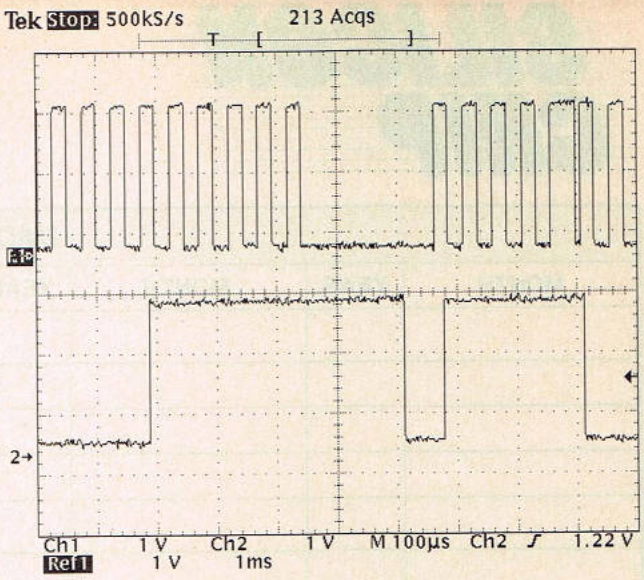


Fig.7: these scope waveforms shows the effect of setting the throttle of channel 5 to maximum reverse. As you can see, the fifth pulse after the sync pause is quite narrow with respect to all the other channels which are set to STOP. The lower trace shows the relevant channel 5 pulse with an expanded time base.

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
0.22µF	220n	224
0.1µF	100n	104
.01µF	10n	103
220pF	220p	221
47pF	47p	47

bridge rectifier are mounted on a PC board measuring 162 x 101mm and coded 09102981.

Begin by carefully inspecting the PC board for any defects such as shorts, open circuit tracks or undrilled holes and correct as necessary.

Our suggested assembly procedure is to progressively install components relevant to particular circuit sections, power them up and test and then move to the next section. The component layout for the PC board is shown in Fig.4.

With this in mind, install all the links first and then the 10-way insulated terminal block at one end. Now install the components for the +12V and +5V power supplies. In particular, install the 2200µF filter capacitor, the 3-terminal regulators (REG1 & REG2), the associated 1µF and 10µF bypass capacitors, LEDs 1 & 2 and resistors R20 & R21.

You will need a DC power supply which puts out at least 16V. Now connect +16V to the V+ terminal on the connector block and the 0V line to the 0V terminal. Both LEDs should light up and you should be able to measure +12V from REG1 and +5V from REG2.

Now install the components concerned with the master clock, This means IC1, IC2, IC12, LEDs 3-6, the 32kHz watch crystal and associated components. IC sockets are optional but are only really worthwhile for the more expensive ICs.

Make sure the LEDS are oriented correctly and the same applies to the ICs. Check your work carefully and then apply power. LEDs 1 & 2 should light up as before and the other four LEDs should flash. LED6 should turn on for 1-second intervals, LED5 for ½-second intervals, LED4 for ¼-second and so on.

This display confirms that the master clock is functioning correctly. If the LEDS don't light in this way, double check your work for errors and don't proceed any further until this part of the circuit is working as it should.

Now you can install IC11, resistors R16-R18 and capacitors C16 and C17. Then reapply power and check the +8.8V (Reverse), +5V (Stop) and +1.2V (Forward) terminals on the connector block.

Next, install IC10 and resistors R14 and R15 (adjacent to IC9). Then apply power and check to see that +2.5V is present at pins 1, 7, 8 & 14 of IC10 and at the S1, S2, S3 and S4 terminals on the connector block.

Now install the remaining ICs and a 16-pin socket for the 16-pin header. This accepts the signals from the handheld throttles.

Install the three transistors, four diodes and the remaining ICs, resistors and capacitors by following the component layout diagram of Fig.4.

Double check your work for any errors, eg, diodes and transistors incorrectly inserted. When satisfied that all are correct, apply power and switch on. As before, all LEDS should either light or flash continuously.

Setting up

You will need a conventional analog multimeter set to read 10V DC or more. Now measure the voltage at TP A, adjacent to pin 7 of IC8. If you can't see this IC, it's located in the top lefthand corner of the PC board in Fig.4.

Adjust trimpot VR1 so that the voltage at TP A is +6.2V. This ensures that the pulse waveform with no input signal has a mark/space ratio of 1:1.

This completes the Command Station. Next month we will discuss and build the Power Station and throttles.

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Jaycar ELECTRONICS

PRE CATALOGUE SALE!!!

Prices valid until February 28th.

All prices in Australian Dollars - New zealand customers please ask for New Zealand prices.

MEMOKEY 20 SECOND VOICE RECORDER NEW

It's a hectic world out there, so remembering things on-the-fly ain't easy! Get some help with this small lightweight voice recorder. Dictate important pointers as they come to mind, memos, meetings, appointments, etc. Mounted on a keyring, so it's with you all the time. records 3 separate messages, total 20 seconds.

Cat. XC-0275 **$24.95**

WHITE RUB-ON LETTERING NEW

By popular demand! Same symbols as our black lettering (NL-2920), only white. At last, professional lettering transfers for black panels! Features 0 - 10 numbers, min./max., volume, balance, arrows,etc. 1 sheet measuring 145x210mm. **Black shown**

Cat. NL-2922 **$3.95**

HARD DRIVE BIBLE NEW

The ultimate book on hard drives. 430+ pages, Hardcover. See Dec. 97 adv. for full details. Cat. BC-1210

$49.95

SOUNDFEEDER FM WIRELESS TRANSMITTER

This stereo FM transmitter accepts line level inputs from CD players, etc. If you own a car hi-fi deck that doesn't have line level inputs, then this is what you need. The frequency that the soundfeeder transmits on is selectable, and will transmit to any FM receiver up to 2 metres away. Accepts one single AA battery (not included), with a 3.5mm stereo phone plug input cable included.

NEW MODEL

Cat. AR-1752 **$49.95**

DUAL FAN PC VENTILATOR

The latest generation of processors are faster and smaller than ever. Add to that, smaller enclosures and hardware and you've got the potential to generate volumes of hot air. Fix it! A fantastic new product that helps keep your PC hardware cool and running efficiently. Simply mounts inside the computer case, with the dual fans extracting hot unwelcome air from inside. 12V power derived from your PC power supply. Mounting hardware and power leads supplied. A must for any PC.

NEW

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ADJUSTABLE REGULATED 1.5A POWER SUPPLY

NEW

This adjustable output voltage supply is fully regulated and delivers a respectable 1.5 Amps current. Selectable voltages include 3, 4.5, 6, 7.5, 9 and 12VDC. Features on/off switch, large easy to grip voltage selector, power LED, short circuit protection automatic thermal cutoff and overload protection output by large 4mm binding post screw terminals. Electricity Authority approved. Size 135(L) x 98(W) x 68(H)mm.

Cat. MP-3035 **$49.95**

MINI CAMERAS

We now carry a great range of tiny PCB based cameras for surveilance, poolside monitoring, security or just plain fun! Each camera has a composite video output that plugs into any VCR's video input, or into the RF input by using a RF video modulator. Normal working voltage 12VDC.

CCD CAMERA WITH CASE, IR LED & LEAD Camera in a box! Complete with lead + RCA plug. Cat. QC-3450

$159.50

CMOS PCB CAMERA MODULE A great surveilance camera.

Cat. QC-3440 **$99.95**

CCD PCB CAMERA MODULE Tiny! Just 32 x 32 x 15mm. Unbelieveably small.

Cat. QC-3460 **$125**

CCD PINHOLE CAMERA Hide the eye! Secure surveilance through a pinhole. Cat. QC-3461

$125

CCD CAMERA - METAL CASE Comes in a black metal case, 35 x 35 x 15mm + bracket and lead. Cat. QC-3470

$145

PERSONAL DIGITAL ORGANISERS

Two great new organisers for 1998. These are both high quality databanks with features only normally seen on big name organisers. Both feature 12/24 hour clocks with world time and daily alarm. Powered by two lithium batteries, each organiser has a large LCD display, auto power off, secret code and free memory indicator. Functions include telephone directory, schedule reminder, memo, accounts memory and percentage. Don't spend big dollars on a personal organiser until you see these.

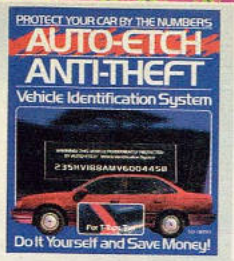
Cat. QM-7340 32Kb **$49.95**

Cat. QM-7345 64Kb **$65.00**

NEW

NEW 1998 CATALOGUE DUE OUT NEXT MONTH

CAR WINDOW ETCHING KIT DEAL



Spend $20 at any Jaycar Store in February, and you can buy for $5 a car window etching kit worth $29.95. See 97 Cat. page 75 for full details. You can also buy up to 2 extra tubes of etch cream for $1.50 each if you wish. (Worth $9.95 ea.)

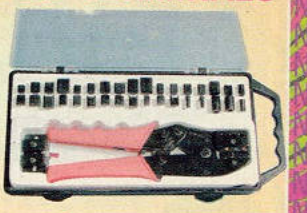
KIT Cat LA-5120 **CREAM** Cat LA-5125

24VDC TO 3 - 12VDC

Regulated at 1.2A. See 97 Cat. page 86 for full details. Limited quantity available. Cat. MP-3056

Was $19.95
Save $9.95
Feb. $10

CRIMPING TOOL FOR INSULATED TERMINALS



Includes tool, 34 terminal positions and case. Cat. TH-1928

Was $79.95
Save $30
Now $49.95

4 WAY PARALLEL AUTO PRINTER SWITCH

Connect 4 computers to 1 printer. See 97 Cat. page 161 for full details. Limited quantity. Cat. XC-5080

Was $47.85
Save $17.85
Feb. $30

SINGLE SHIELDED CABLE

This is in our catalogue as Mic cable, but does not have a cotton filler. It can be used as audio cable, or wherever a single shielded cable is required. Specs: Lead with wire 7/0.12mm, shield 28/0.12mm, OD 4.6mm, colour - black. Cat. WB-1520

Save Big $$$$

Cat. Price $1.70m
$116/100m roll.
February. Price 80¢ m
$40/100m roll.

REMOTE CONTROL SWITCHES

Double pole latching and momentary.

1 CH With 1 transmitter
Cat. LR-8828
Was $59.95
Feb. $49.95
Save $10
Extra transmitters
Cat. LR-8829
$17.95

SAVE $10

2 CH With 1 transmitter
Cat. LR-8826
Was $79.95
Feb. $69.95
Save $10
Extra transmitters
Cat. LR-8827
$19.95

MAINS (TWIN/EARTH) HOUSE WIRING CABLE NEW

Twin Earth Flat Cable
1.0 sqmm 1/1.13, 10 amp (lights)
Cat. WB-1565 **$1.20/m or $95/100m**

Twin Earth Flat Cable
2.5 sqmm 7/.067, 20 amp (power)
Cat. WB-1568 **$1.75/m or $140/100m**

10 metres or more - less 10%

DISCO LASER

This aptly titled laser pointer generates laser light patterns using a unique floating mirror mounted on a tiny, slinky spring. The smallest hand movement generates an eye dazzling display of spherical patterns. As well as this, the Disco Laserpointer can quickly switch over to become a conventional still-beam pointer. 5mW power output. Size: 90(L) x 23(W)mm. Includes 3 x LR44 batteries & nylon cord to serve as a necklace.

NEW

Cat. ST-3105 **$69.95**

CANNON AT JAYCAR!!! NEW

JAYCAR HAVE JUST BEEN APPOINTED A DISTRIBUTOR FOR ALCATEL CANNON CONNECTORS.
Bulk users, contact our Wholesale Department for great prices.

3 PIN CHASSIS MALE
Cat. PP-1050 **$4.75**

3 PIN LINE MALE
Cat. PP-1052 **$5.95**

3 PIN CHASSIS PLASTIC MALE
Cat. PP-1054 **$3.95**

3 PIN LINE IDC MALE
Cat. PP-1056 **$6.95**

3 PIN CHASSIS FEMALE
Cat. PS-1060 **$6.50**

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Cat. PS-1062 **$5.95**

3 PIN CHASSIS PLASTIC FEMALE
Cat. PS-1064 **$3.95**

3 PIN LINE IDC FEMALE
Cat. PS-1066 **$6.95**

DISTRESS STOCK PURCHASE DUAL CAT5 (NETWORKING) WALL PLATE

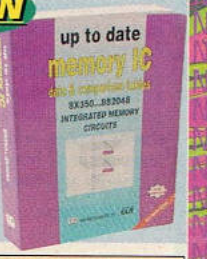
NEW

These are a quality Clipsal brand wall plate with two CAT 5 networking sockets mounted behind the plate, each with its own spring loaded protective sliding cover. White in colour, it's supplied with two CAT5 sockets, strain relief hardware, glass panel & mounting screws. Limited quantity. Cat. PS-1450

We've seen these advertised elsewhere for $19.95.

We've got them for just $12.95

MEMORY IC DATA & EQUIVALENT TABLES NEW



Just Under 1000 Pages of data! This is by far the best book we have ever seen on programmable integrated memory devices, ie all solid state memory except unalterable ROM. Almost 2000 basic device types are described from RAM, static RAM, dRAM, PROM, EPROM, EEPROM, One-time programmable EPROM, PROM, Programmable & erasable ROM, flash EPROM & EEPROM and FIFO devices. Starts from part No. 8X350 and finishes at 882048.

Cat. BM-4575 **$49.95**

SHORT CIRCUITS

IDEAL FOR KIDS!

Short Circuits assumes they know nothing about electronics. The book shows you what electronic components look like and how they work. There are 21 projects to build and all the components are supplied to build all the projects. There is no soldering required and all components are mounted on a baseboard with springs. Some projects are: •Short circuit tester •Police siren •Sound effects •Light chaser •Solar powered radio •Amplfier •Buzzboard & more.

SHORT CIRCUIT BOOK & PROJECT KIT

Cat. KJ-8502 **$24.95** *Used In Schools

SAVE $$$$ ON POLYSWITCH SPEAKER PROTECTION

MOST BELOW 1/2 PRICE

See 97 Cat. page 49 for full details.

No.	Wattage 8Ω	Cat.#	Was	Now
RXE075	10W	RN-3460	$6.95	$3.50
RXE090	15W	RN-3462	$7.25	$3.50
RXE110	22W	RN-3464	$7.50	$3.50
RXE160	46W	RN-3466	$7.95	$3.95
RXE185	63W	RN-3468	$8.50	$3.95
RXE250	112W	RN-3470	$9.95	$4.25
RXE300	162W	RN-3472	$10.95	$4.50
RXE375	253W	RN-3474	$12.95	$4.95

SPIRAL BINDING

KEEP WIRING TIDY! Are you sick of messy cabling behind your Hi Fi video or computer or TV? Spiral binding is available in 2 sizes, and is easily wrapped around bunches of cables to keep them tidy. Colour is black.

NEW

6MM DIA 2.5 METRE
Cat. HP-1220 **$4.95**

12MM DIA 1.5 METRE
Cat. HP-1222 **$4.95**

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RECORD LOW PRICES ON QUALITY MAXELL BRAND GREEN CD-R

RECORDABLE CD'S NEW

We dare you to find a better deal on genuine Japanese made 74min 680MB recordable CDs
Cat. XC-4711

1-9 $4.75ea
10-99 $4.28ea
100+ $3.85ea

DON'T LET THE COLOUR FOOL YOU! THEY ARE "AS GOOD AS GOLD"

network VODAFONE from JAYCAR

ALCATEL EASY

$49*

- Small size 133x55x 30(D)mm
- 5 hours talktime
- 120 hours standby
- Use 3xAA Alkaline batteries in emergencies

Cat. YT-7500

NETWORKER

$59*

- Nokia handset
- Bonus Ni-Mh battery
- Free premium insurance for 3 months (worth $28.50)
- Free 15 mins. call every month

Cat. YT-7510

NOKIA 3810

$269*

- Small size 136x45x27(D)mm
- Big screen display
- Data and Fax compatible
- Ni-Mh battery up to 95 hrs standby 165 mins. talk

Cat. YT-7520

*$30 month access includes 15 minutes FREE calls each month

*Connect to a 12 month Vodacall access plan. One off $65 connection fee. Lifestyle 30 plan includes 15 mins of free calls every month (excluding special services & international calls). The total minimum cost over 12 months including 180 minutes free calls: Alcatel Easy $474, Networker $484, Nokia 3810 $694 Limit 2. Trade not supplied. *Conditions apply. *Offer expires 28th February 1998.

RECORDABLE CD'S 74MIN 680MB

We WILL NOT be beaten on price. TELL US IF WE'RE WRONG!

Genuine gold quality JAPANESE MADE recordable CD's at the best price in town! Cat. XC-4710

1-9 $5.99ea
10-99 $5.39ea
100+ $5.20ea

Remember! Each disc is supplied in a quality CD jewel type (i.e. standard) clear plastic case.

SCOOP PURCHASE OF THE DECADE AURA INTERACTOR

Plug it into computer games, stereos etc, then put the back pack on and feel all the low frequency sounds. See previous ads for full details.

Cat. XC-1000

WAS $249
THEN $49.95
FEBRUARY $29.95

SAVE $210!

AURA ADAPTOR CABLE FOR N64 & PLAYSTATION

This pack contains all the leads required to attach the Aura Interactor to your games console and stereo system. Includes RCA piggyback lead, 3.5mm phone to 2 x RCA adaptor lead, RCA joiners and stereo Hi Fi RCA cable. Total value $17.40

Cat. XC-1001 $10.00

12V 26W TWIN TUBE FLUORO LIGHT

An ideal light for campers, boats, caravan, 12V homes, MIR space station, etc. Current draw 1.25A. Size 600(L) x 76(W) x 25(D)mm
Cat. ST-3021

Was $29.95
Feb. $22.95
Save $7

50% OFF 30 AMP BATTERY CLIPS

Cat. HM-3078 RED
Cat. HM-3079 BLACK

Were $1.50ea
Feb. 75c ea

80W SOLDERING IRON

A heavy duty iron for tough valve chassis, heavy cabling or general electrical work. Fully Electricity Authority approved.
Cat. TS-1485

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Feb. $20
Save $9.95

INCREDIBLE SAVINGS ON INTERIOR SECURITY ALARMS

INTERIOR ALARM AND PIR

This alarm has a built-in passive infra red (PIR) detector and 100dB piezo screamer. There is also a panic button for emergencies. It's 9 volt battery operated (battery not included), or from 240V with an optional adaptor - use Cat. MP-3006 $15.50. Also includes 2 deterrent stickers. Unit size: 137(H) x 80(W) x 53(D)mm. Ideal alarm for home units garages, caravans, boats, office etc, etc. **Cat. LA-5150**

Were $49.95 Save $20.00
Feb $29.95

TELKO WINDOW / DOOR MAGNETIC SENSOR ALARM

This small alarm is designed to be mounted on a window or door. When the door / window is opened, a built-in 90dB alarm sounds.
Cat. LA-5165

Were $9.95 Save $3.00
Feb $6.95

TELKO PROGRAMMABLE ENTRY ALARM / CHIME

This unit simply mounts on a door or window. When the door or window is opened the unit either chimes, or the siren goes off. Requires 3 x AAA alkaline batteries (not supplied). Uses magnetic sensor switch for contacts. Size: 132(H)x80(W)x28(D)mm. **Cat. LA-5160**

Were $24.95 Save $7.00
Feb $17.95

TELKO VIBRATION DOOR / CHIME / ALARM

This unit simply hangs on the door knob inside a room. When the door is opened or shaken it will "sound".
Cat. LA-5170

Were $7.95 Save $2.00
Feb $5.95

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

POWERBEAT MULTIMEDIA SPEAKERS

Beaut speakers for your PC with built in amplifiers and mounting brackets for attaching to your monitor (shielded, of course!!). Volume control and bass button included. Will run from either 4 x AA batteries (not supplied) or use MP-3012 plug pack. See 97 Cat. page 159 for full details. Cat. XC-5162

Was $39.95pr. Save $10pr.

Feb. $29.95pr

17 PIECE OFFSET RATCHET DRIVER SET

A handy toolset for getting into tight places. Includes: •Slotted 4/5/6mm, •Phillips #1-2 •Posidrive #1-2 •Torx 10-15-20mm •Slotted bits, 5-6-7-8mm •Phillips 9-10mm Cat. TD-2045

Was $16.95 **Save $4**

Feb. $12.95

6 WAY POWER OUTLET WITH MAINS FILTER AND TELEPHONE LINE PROTECTION

A great mains filter to suit telephone products too - computer modems, faxes and answering machines. Protect your computer from spikes and surges. Features 6 protected power outlets, resetable circuit breaker, thermal fuse for overload protection, 2400 watts handling. Electricity authority approved. Cat. MS-4030

Was $32.95 **Save $3**

February $29.95

REED / MAGNET ASSEMBLY

N.O and N.C on one assembly. Screw terminators with self adhesive or screw mount. Cat. LA-5070

Normally $5.95 ea.

February 10 for $39.50

CAR CD PLAYER MOUNT

Mount your portable CD player in your car. Features •Anti-vibration suspension •Quick release mount •Padded jaws to hold CD. Quality unit made in Taiwan. Refer Oct '97 ads for details. Cat. AR-1770

Was $39.95

Feb. $29.95

Save $10

TORX AND TAMPER RESIST TORX SCREW DRIVER DEAL

Quality screwdrivers with slip proof handles and made from chrome vanadium.

Cat. #	Description	Was	Feb.	Save
TD-2060	T8 TORX	$6.50	$4.50	$2.00
TD-2061	T9 TORX	$6.50	$4.50	$2.00
TD-2062	T10 TAMPER RESIST TORX	$7.95	$5.50	$2.45
TD-2063	T15 TAMPER RESIST TORX	$7.95	$5.50	$2.45
TD-2064	T20 TAMPER RESIST TORX	$7.95	$5.50	$2.45
TD-2066	T25 TAMPER RESIST TORX	$9.95	$6.50	$3.45

BUY THIS LOT FOR $29

SAVE $27.75 ON 1997 PRICES !!

POKER / BLACK JACK GAME

You've blown your cash at the casino, so take your frustrations out on this fun LCD game. Just like the "cardies" in pubs and clubs. See 97 Cat P180. Cat. QM-7360

Was $17.95 **Save $5.95**

Feb. $12.00

"NOISEBUSTER" HEADPHONES

These headphones are amazing!! They're not only high quality headphones, they reduce outside noise as well. Facts: •Up to 95% reduction in aircraft cabin noise. •Up to 80% automobile reduction. •Up to 60% lawn mower reduction. See 97 Cat. page 53 for full specifications on these incredible headphones. Cat. AA-2000

Was $99

Feb. $79

Save $20

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mailorders@jaycar.com.au

EMAIL YOUR ORDERS NOW

THINPHONE 10 MEMORY TELEPHONES

NOT AVAILABLE AT DEALERS

A quality, reliable phone at a great special price! Pulse and tone switchable, 10 memories, last number redial and timed call / easycall compatible. Cat. YT-7050

Was $39.95 **Save $5**

February $34.95

DATABANK / CALCULATOR WATCH

Store your 50 most used 'phone numbers on your watch!! Features time, alarm, 3-line databank display. See 97 Cat. page 172. Cat. XC-0260

Was $19.95 Save $9.95

February $10

SUPER DRILL SET

These are fantastic tools. Perfect for drilling, polishing, routing, shaping, sanding and milling. Supplied with collets, grindstones, grinding wheel, drill bits, 240V mains plugpack. See 97 Cat. page 103 for details. Cat. TD-2460

Was $59.95 Save $10

February $49.95

ROTARY COAX STRIPPER

Attention installers! Cut installation time by stripping outside cable jacket and inner conductor in one operation. Suits RG58/59/62/6 and 3C2V 75Ω cable. Cat. TH-1820

Was $24.95 **Feb. $19.95** **Save $5**

PHILLIPS DOME TWEETER AD11600/T8

Don't look any further for a great performing tweeter - these are superb. 100WRMS system, 95dB 1W/1M. See 97 Cat. page 32 for full specifications. Cat. CT-2012

Was $32.50

Feb. $25 **Save $7.50**

4 DOOR CENTRAL DOOR LOCKING KIT

Kit includes 2 master and 2 slave solenoids and the power relay. Be careful! Other kits advertised only have 1 master & no relay box! Includes wiring. You can't beat our price! Cat. LR-8830

Cat. Price $89

SAVE $30

Only $59

Jaytech PRECISION 5" CUTTER

Actually made for the German market, these Jaycar cutters are stainless with a polished finish.
Cat. TH-1886
Only $14.95

3 - 15V ADJ. REGULATED POWER SUPPLY

1 YEAR WARRANTY

Save $20

See 97 Cat. page 84 for full specs. Cat. MP-3085
Was $179.50
Feb. $159.50

4 PC MINI PICK AND HOOK SET

Features stainless steel heat treated blades.
Cat. TH-1762
Was $9.95
Feb. $6.95
Save $3

SAVE $5 ON "FULL HOUSE" BIT SET

All the odd bits - Tri wing, Tamper proof, Torx, Spanner (snake), In-hex (allen), Torque.
Cat. TD-2035
~~$29.95~~ ~~$19.95~~
Jan $14.95

PA SPEAKER BIN ENCLOSURE DESIGN BOOK

Fane Acoustics (UK) makers of speakers for the likes of Pink Floyd, David Bowie, Iron Maiden etc. Cram packed with hot design info!
Cat. BF-4150
Was $14.95
Feb. $9.95

Save $5

80W Jaytech SOLDERING IRON

A heavy duty iron for tough valve chassis, heavy cabling or general electrical work. Fully Electricity Authority approved. Cat. TS-1485
Was $29.95
Feb. $20
Save $9.95

SOLDERING AID KIT

4 pc kit to assist soldering. Supplied in plastic wallet.
See 97 Cat. page 107.
Cat. TH-1760
Was $6.95
Feb. $4.95
Save $2

SPEAKER CABLE ON CONVENIENT 30M ROLLS

THE SMART WAY TO BUY SPEAKER CABLE SAVE $$$

What a great idea! If buying a bulk 100 metre roll is a touch over the top then 30 metres should do the trick. Two sizes to choose from.

LIGHT DUTY FIG.8
Cat. WB-1703 **$8.95**

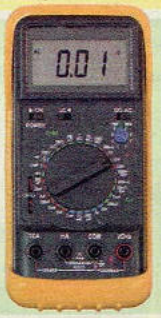
HEAVY DUTY FIG.8
Cat. WB-1709 **$17.50**

20 MHZ LOGIC PROBE

See 97 Cat. page 25 for full details.
Cat. QT-2210
$29.95

INDUCTANCE DMM

A full feature DMM with •Capacitance •Temperature •Transistor test •Continuity •3.5 digits •Holster and carry bag included.
Cat. QM-1480
Was $99.95
Feb. $89.95
Save $10.00



NOVIK SQUARE CONE TWEETER

Ideal replacement tweeter 30WRMS system. See 97 Cat. page 31 for details.
Cat. CT-2002
Was $7.95
Feb. $5
Save $2.95

12" PAPER CONE WOOFER

Black cone, rubber surround, 80Ω, 50WRMS. See 97 Cat. page 38 for full details.
Cat. CW-2125
Was $42.50
Feb. $32.50
Save $10

12V COLOURED NEON UNDERBODY TUBES

Mount under your car or use in store displays, night clubs, home lighting effects, etc. Draws approximately 350mA at 12VDC
Cat. ST-3120 BLUE
Cat. ST-3126 PURPLE
$49.95ea.

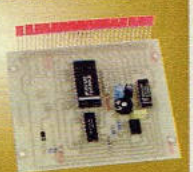
NEON TUBE SOUND MODULATOR KIT

Refer Silicon Chip 5/97
Modulate our neon tubes to the beat of your car stereo! PCB components included.

Cat. KC-5221
$7.95

IMPROVED KNIGHTRIDER LED SCANNER KIT

Refer S.C. magazine 5/96.
16 LEDs that scan back and forth. 12VDC.
Cat. KC-5204
Was $20.95
Feb. $15.95
Save $5



CONTINUITY TESTER KIT

Refer S.C. magazine 2/97.
Not just any old continuity tester - audible tone generated depending on resistance. Cat. KC-5219
Was $20.95
Feb. $15.95
Save $5

F61 FLUSHMOUNT WALL SOCKET

Standard power point size. Accepts F59 plug both sides of socket.
Cat. LT-3040
Was $4.95
Feb. $2.95
Save $2

0.30V MU-45 PANEL METER

Cat. QP-5022
Was $19.95
Feb. $14.95
Save $5

CRITICAL SYSTEM ALARM KIT FOR CARS

Refer EA magazine 3/97.

Monitor critical parts on your car warning lights such as brake and oil / engine temp. An inexpensive kit that could save you heaps!
Cat. KA-1791
Was $16.95
Feb. $12.95 **Save $4**

HIGH CURRENT POWER CABLE

The current stock we have is not quite up to full 4G & 8G specs. Its slightly smaller, but will still do the job perfectly in 99% of installations Your chance to save !!

SAVE

8GA POWER CABLE

Normally $2.95 mt. / $220 100mt. roll.
Now $1.95 mt. / $170 100 mt. roll.
RED Cat. WH-3070
BLACK Cat. WH-3072

4GA POWER CABLE

Normally $7.95 mt. / $325 50mt. roll.
Now $5.50 mt. / $225 50 mt. roll.
RED Cat. WH-3074
BLACK Cat. WH-3076

ALARM STICKER 72 X 32mm

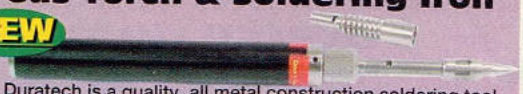
Durable, self adhesive. Sticks to windows. Use on cars or home. Cat. LA-5100
Normally $1 ea 5 for $4
(Buy 4 get 1 free)

50% OFF MYLAR 27MM SPEAKER 8Ω

Cat. AS-3002 **Was $2**
Feb. $1

DURATECH GAS TORCHES
Gas Torch & Soldering Iron

NEW



Duratech is a quality, all metal construction soldering tool. It runs on Butane gas, therefore needs no cords or mains power, and can be used anywhere. Adjustable 10 to 60 watts and uses standard Butane cigarette lighter gas. Supplied with a flame tip for welding, shrinking heatshrink tubing etc and a solder head! Supplied with flame torch tip and conical soldering tip/catalyst.
Cat. TS-1685 **$34.95**

5 in 1 Gas Soldering Iron Kit

NEW

This kit uses the same tool as shown above. The accessories supplied in the kit give it a much larger range of uses. The kit includes: •The tool with metal body •Soldering head and catalyst •5 soldering tips: conical, 2.5mm diagonal, 3.5mm diagonal, 3.5mm chisel, 7mm chisel •Pencil flame head, hot knife head, hot blower head, flat flame head •Solder sponge •Tube of solder •Case to hold everything
Cat. TS-1690 **$59.95**

Piezo Micro Torch

NEW

Features include: •Self igniting •Easy to Refill •Adjustable flame •Portable •Cordless •1300°C •Butane Gas Powered Ideal for welding, brazing, wire soldering, jewellery, shrinking heatshrink, plumbing, hobbyist use.
Cat. TS-1675 **$44.95**

Weller® portasol
PROFESSIONAL 100K SOLDERING IRON KIT WITH PIEZO IGNITION

NEW

The Weller PSI-100K is an extremely robust soldering tool kit, which is ideal for trades people and serious hobbyists. Kit includes: •Soldering tool and cap •Soldering tip 3.2mm chisel •Soldering tip 4.8mm chisel •Hot blow tip •Hot knife tip •Sponge and holder •Case
Cat. TS-1730 **$159**

EXTRA SOLDERING TIPS AVAILABLE
1mm Single Flat Cat. TS-1732
2.4mm Single Flat Cat. TS-1734 **$22.95ea.**

9V AC 1 AMP PLUG PACK BARGAIN

We've bought a quantity of 9V AC 1 Amp plug packs which are terminated to a 2.5mm DC plug. Fully SAA approved No. N14311
Cat. MP-3024 **$14.95**

Weller® WTCPT
SOLDERING STATION

NEW

**FREE 1KG 1MM ROLL OF SOLDER WITH EVERY TS-1350 PURCHASED

The Weller station is known as one of the best soldering stations around. It's made in Australia and features a 48W heating element. To change the temperature, simply change the tips! Supplied with a 1.6mm PTA7 screwdriver tip. The ultimate for the professional or serious hobbyist.
Cat. TS-1350 **$189**

TIPS TO SUIT
Plato brand. Suitable for WTCPN/S/T stations. All tips 1.6mm screwdriver type.
Cat. TS-1352 PTA6 - 315°
Cat. TS-1362 PTA7 - 370°
Cat. TS-1365 PTA8 - 430°
All $8.95 each

SPEAKER CARPET

Super thin carpet, easy to work with, great protection. Colour black, 3mm thickness, size 1 mtr. x 1.8mtrs. Cat. CF-2755
Was $32.95 Feb. $29.95 Save $3

SPEAKER GRILLE CLOTH

Size: 1 x 1.5metres. Use with our frame kit CF-2750, or replace worn out cloth or foam. Black. Cat. CF-2752
Was $16.50 Feb. $12.50 Save $4

20KΩ LOG MOTORISED VOLUME POT

As used in our PRO4 preamp kit. Dual gang pot with 1/4" shaft. See 97 Cat. page 145 for full details.
Cat. RP-3850
Was $17.95 Feb. $10 Save $7.95

THREE PIECE COUNTERSINK BIT SET

The easy and professional way to countersink holes. Use with standard electric drill. Bit sizes 12, 16 and 19mm diameter.
Cat. TD-2028
Was $6.95 Feb. $4.95 Save $2

GREAT SAVINGS ON COMMANDER/PABX EXTENSION LEADS

All leads have 6 wires instead of the usual 4.
3 metres. Cat. YT-6016
Was $15.95 Now $9.95 Save $6
10 metres Cat. YT-6018
Was $18.95 Now $11.95 Save $7
15 metres Cat. YT-6019
Was $22.95 Now $14.95 Save $8
NOT AVAILABLE FROM DEALERS

NEW ZEALAND Mail Order Tollfree Hotline 0800 4 JAYCAR

EMAIL ORDERS: mailorders@jaycar.com.au **WHOLESALE EMAIL: wholesale@jaycar.com.au**

Jaycar ELECTRONICS

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FAX: (02) 9743 2066

Quality System — Quality Endorsed Company ISO9002 Lic 6143 Standards Australia

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ROAD FREIGHT ANYWHERE IN AUST (up to 20kg) $14.00
POST & PACKING $10 to $24.99=$4.00 $25 to $49.99=$5 $50 to $99.99=$7 OVER $100=$8

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NEW JAYCAR STORE IN NEW ZEALAND •14A Gillies Ave. Newmarket. Auckland •Ph: (09) 529 9916

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Jaycar ELECTRONICS

No. 1 For Kits

HIGH PERFORMANCE DI BOX KIT

NEW

Previous Model Shown

Refer Electronics Australia Feb 1997. A professional direct injection preamp using JFET technology to suit PA and audio recording. The kit features very low noise, low current drain (via phantom power), high common mode rejection (CMRR) and wide dynamic range. The Jaycar kit is absolutely complete with diecast box, silkscreened front panel, metal XLR connector, PCB, high spec. transformer plus components. Beware of inferior versions of this kit offered by other suppliers.

Cat. KA-1805 **$49.95**

12V 4 CHANNEL LIGHTSHOW KIT

NEW

Refer: Silicon Chip January, 1997. Full featured low voltage light controller. The Jaycar kit includes case, PCB, punched /silkscreened front and rear panels plus all electronic components. See previous Adverts for full details.

Cat. KC-5240 **$119.95**

CABLE BREAK FINDER KIT

NEW

Previous Model Shown

Refer Electronics Australia February 1998. Your faithful multimeter may tell you there's a break in your cable, but won't tell you where in the cable the break is. Is the break at the centre, or at the end (which end)? This tester tells you where - saving service time and eliminating the need to cut off connectors in a vain attempt to locate the fault. Kit is complete with case, silkscreened front panel, PCB, RCA, phone and XLR connections plus electronic components. 9V battery and IC socket also supplied at no extra charge.

Cat. KA-1804 **$34.95**

TWO 12V HALOGEN LAMP FLASHER KIT

NEW

Refer:Silicon Chip Jan 97. Flash two halogen lamps alternatively at rates from once a second to once every 3 seconds. Kit is complete with two 50W halogen lamps & holders, PCB plus electric components. Requires 12VAC or DC.

Cat. KC-5241 **$34.95**

LINE CARRIER LINK ADD-ON FOR HOME AUTOMATION

NEW

KA-1799 Shown

Refer Electronics Australia Feb 1998. This add-on circuit converts our KA-1799 line carrier link kit from two channels to four channels. In practice, you could add 32 of these modules for a total of 128 commands, so there's plenty of room for experimenting. A fun, yet extremely practicable and versatile project. Kit includes PCB's, switches plus all electronic components.

Cat. KA-1803 **$19.95**

LINE CARRIER LINK
Refer Electronics Australia Nov 1997.

Cat. KA-1799 **$69.95**

REMOTE KEYPAD CASES

Panel punched for LEDs. Hinged door. Size 136(W) x 103(H) x 20(D)mm.

Cat. HB-5600 GREY

Cat. HB-5601 CREAM

Feb. 2 for 50c
Normally 50c ea

12" PAPER CONE WOOFER

Black cone, rubber surround, 8Ω, 50WRMS. See 97 Cat. page 38 for full details.

Cat. CW-2125

Was $42.50
Feb. $32.50
Save $10

REMOTE CONTROL SWITCHES

NEW HIGH PERFORMANCE MODELS FOR '98

The Garrison return! These were sold by us previously until they were replaced by lower priced units. Well, what can we say, they are back again! The transmitters feature telescopic antennas for extra range (now an incredible 50 metres), plus sliding covers to prevent accidental transmission. The receivers and are mounted within high quality ABS cases. Each model includes two transmitters, receiver and instructions, and security code programmable.

LATCHING UNIT

Includes both N/O and N/C contacts. 11-15VDC input voltage. 24VDC/1A relay contacts.

Cat. LR-8820 **$89.95** SPARE TRANSMITTER Cat. LR-8821 **$23.95**

MOMENTARY UNIT

Receiver features 2 relays, both can be wired in either N/O or N/C contact configuration. Receiver input voltage 11-15VDC, 120V/5A relay contacts. Cat. LA-8822 **$109.95**

SPARE TRANSMITTER Cat. LA-8823 **$23.95**

** Transmitter size 55 x 37 x 13mm, receiver size 87 x 61 x 33mm. Ideal application include car and home alarms, central locking, appliance switching etc.

NEW LITHIUM 35mm SLR CAMERA BATTERIES

Sick and tired of paying too much for lithium batteries? We were, so we've done something about it. We have the 4 most common types available. Continuous max current drain for all 4 is 1A. Nominal capacity is 1300mAH.

1. CR123A: 3V (replaces EL123AP, K123LA and DL123A) Cat. SB-2400 **$9.95**

2. CR-P2: 6V (replaces EL223AP,K223LA,DL223A) Cat. SB-2401 **$17.95**

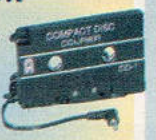
3. 2CR5: 6V (replaces EL2CR5, KL2CR5 & DL245) Cat. SB-2402 **$17.95**

4. CR2 (replaces ELICR2, KCR2 and DLCR2) Cat. SB-2404 **$9.95**

OPEN AN ACCOUNT WITH JAYCAR

See our store manager for details

CD TO CASSETTE ADAPTOR



Play your portable CD player through your car cassette player.

Cat. AR-1760

Was $19.95 Save $5

Feb. $14.95

ACTIVE SUBWOOFER AMPLIFIER MODULE

NEW

Our new Active Subwoofer Amp Module will deliver 150W RMS into 4Ω and 100W RMS into 8Ω. Its the easy way to add a subwoofer to your existing stereo/ home theatre Hi Fi system. Operates on 240V. Designed to fit into the back of most subwoofer cabinets. A simple 190 x 240mm cutout is required. Hardly any internal volume is lost. Call for specifications.

$299

SUBWOOFER AMP DEAL

Subwoofer Amp Module Cat. AA-0500 **$299**

10" Subwoofer Cabinet Kit Cat. CS-2532 See Cat P54. **$99**

Re/Sponse 10" 4Ω Carbon Fibre Woofer Cat. CS-2244 See Cat P59. **$149.50**

This Woofer outperformed most tested in Hot 4's sub car test, & most others were double the price. See Cat P59. **$547.50**

NOW ONLY $499.50

BUY TOGETHER & SAVE $48

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

HEARTFIT-HEART PULSE MONITOR

Christmas is well and truly over - so here's incentive to get fit! Strap the transmitter monitor to your chest and the receiver watch to your wrist. Features •High/low limit alarm •Sports watch water proof to 50mtrs. Improve your cardiac fitness.
Cat. QM-7240
Was $99.95 SAVE
Feb. $79.95 Save $20

PIHER HORIZONTAL TRIMPOTS

Features: •Dust proof enclosure •Polyester substrate •Wiper positioned at 50% •Accidental rotor movement protected.
Specifications: •Max voltage 100V •Nom power 0.1W •Linear curve •Tolerance +/-30% •End resistance 10Ω.

Value	Cat#	Value	Cat#
200Ω	RT-4350	20K	RT-4362
500Ω	RT-4352	50K	RT-4364
1K	RT-4354	100K	RT-4366
2K	RT-4356	250K	RT-4368
5K	RT-4358	500K	RT-4370
10K	RT-4360	1M	RT-4372

All One Price 70c ea

0–30VDC 2.5AMP DIGITAL VARIABLE LAB SUPPLY

NEW

Cat. MP-3082
$199.50

DESK CONSOLE BOX

1/2 Price

Plastic case with aluminium panel. 170(W) x 143(D) x 31(Highest Front) x 55(High at Rear). See 97 Cat. page 93 for full details.
Cat. HB-6092
Was $15.95
Feb. $10 Save $5.95

USED 4116 (D2118) RAM

Limited quantity available.
Cat. ZZ-8419
10¢ Each

12V HALOGEN SPOTLIGHT

A compact handheld spotlight, lightweight and comfortable. 3 mtr. curly cord plus cigarette lighter plug included. Size 125(Diam) x 130(D) x 225(H)mm.
Cat. ST-3023 **Was $22.95**
Feb. $18.95 Save $4

SAVE ON HALOGEN LIGHT SETS

20 WATT LARGE SIZE KIT

Includes •20W lamp - 51mm dia. •Downlight holder (white) •Mains t'former, power lead. Cat. SL-2750 **Value $34.85**
Was $27.95 Feb. $22.95 Save $5

20 WATT SMALL SIZE KIT NOT AVAILABLE FROM DEALERS.

Includes •20W lamp - 35mm dia •Downlight holder (white) •Mains transformer, power lead.
Cat. SL-2755
Value $34.85 Was $27.95
Feb. $22.95 Save $5

VIDEO DOORPHONE

See who is at your front door before opening it! You simply can't be too careful these days. When a visitor presses the doorbell, the video monitor automatically turns on, and you can see who is at the door. With the optional door release, you can remotely open the front door, and let the visitor in if you wish. The camera has IR LEDs for night illumination, and comes with installation hardware for flush or surface mounting. Supplied with clear instructions can easily be mounted by the family handy person. One year warranty.
Cat. QC-3415
DOOR RELEASE TO SUIT $34.95
Cat. QC-3410
Only $469

CELLULAR PHONE CASE MADNESS

Spend $30 at any Jaycar Store in February, and you can buy 1 cellular phone case for only $2.
Limited quantity available.
Not available at dealers.

NOKIA 232	Cat. HC-6902
MOTOROLA 9000	Cat. HC-6906
NEC SPORTZ	Cat. HC-6909
NEC P3	Cat. HC-6910
MOTOROLA MICROTAC	Cat. HC-6912
MOTOROLA FLARE	Cat. HC-6913
NOKIA 2110	Cat. HC-6914.

BUY 10 LESS 10%

HAKKO 936 SOLDERING STATION

NEW

The brand new totally redesigned Hakko soldering station is now available from Jaycar. Hakko is well renowned as one of the best general purpose stations available. Features of the 936 include: •Thinner grip for easier use. •Compatibility with 900 series tips. •Solder dripping from the tip falls into the stand instead of onto the work bench. •Lock screw prevents inadvertent changes in the temperature setting. •Compact size and can be stackable so 2 units takes up the space of one unit. •Centigrade and farenheit temperature scales. SPECS. •Heating element 50W 24V. •Temperature range 200 - 480°C. •Temp stability +/-0.5°. •Tip to ground resistance under 2Ω. •Tip to ground potential under 2mV.
Cat. TS-1610 **$199**

TIPS TO SUIT
0.5mm Conical Cat. TS-1611 **$14.95**
1.6mm Chisel Cat. TS-1612 **$14.95**

PERSONAL ALARM

This personal alarm is small in size and can be used in different ways. To activate alarm simply pull the pin and it sounds this ear piercing, almost unbearable scream which will be sure to attract attention. It has its own beltclip so it can be clipped to pants on a belt etc. Size is 55(W) x 67(H) x 20(D)mm. and colour is black.
Cat. LA-5180
Only $9.95

STICK ON TIME

Need to know the time? In the car, shed, boat, office, kitchen etc, etc, etc. This small round clock also has the date. Supplied with double sided tape. Simply stick it anywhere. Size 40mm dia x 10mm deep. Display height 5.4mm.
Cat. XC-0222
Was $2.95 Feb. $1.95
Save $1

5 " SPEAKER ENCLOSURE

These are made for the Vifa 5" woofer / midrange we sold. These speakers are not sealed, so if they are used in a multiway speaker system, these need to be used to seal the midrange from the woofer. Can be used on any open backed 5" speaker. Cat. CF-2740
Was $9.95 Now $4.95 Save $5

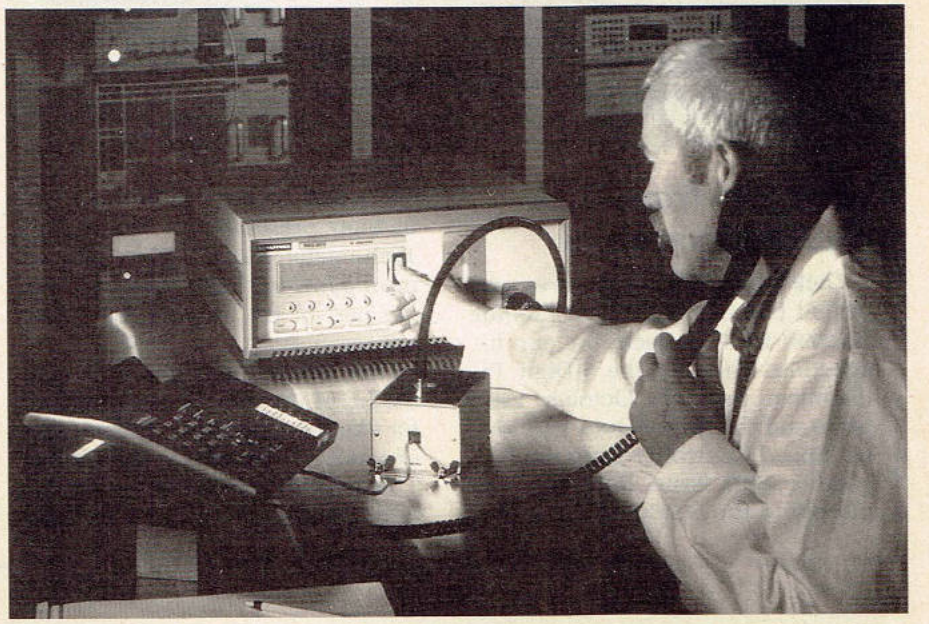
301 PIECE DRILL, BIT & RAWL PLUG KIT

Kit includes: •HSS twist drills •5woodwork drills •5 masonry drills •1 countersink bit •1 magnetic bit holder •6 screwdriver bits •rawl plugs, plus case.
Cat. TD-2425
Was $29.95 Feb. $20
Save $9.95
NOT AVAILABLE AT DEALERS

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

PRODUCT SHOWCASE

Self-calibrating RF simulator



The new microprocessor controlled Schaffner NSG 2070 high frequency generator provides comprehensive electromagnetic susceptibility testing. Although not yet mandatory in Australia, electromagnetic susceptibility tests are often required to be conducted for medical apparatus and also for equipment intended for export. It is also expected that IEC susceptibility standards for mobile phones and other equipment, currently in draft stage, will be introduced in the near future.

The Schaffner NSG 2070 comprises a 100kHz-250MHz synthesiser, 85 watt power amplifier and a range of coupling options including capacitive coupling networks (CDNs), electromagnetic clamps, current injection probe (CIP) and an external monitoring probe. In anticipation of new IEC standards for equipment such as mobile phones, a pulsed mode of operation is already included.

The instrument automatically adjusts the output and creates its own calibration table, using output measurements made at the rate of 900 per decade. An Auto-function calculates and sets the correct frequency sweep rate according to the IEC 1000-4-6 procedure, thus avoiding the need for manual setup and calculation. The test procedure can be interrupted at any time in order to pursue a more detailed examination at a particular frequency and can then be resumed where the test was interrupted.

A liquid crystal display and keypad provide access to all functions. Windows-based software provides setup of all front panel functions and options including test customising and sequencing. Entire test procedures can be saved and compliance reports can be produced automatically.

For further information, contact Westek Industrial Products Pty Ltd, Unit 2, 6-10 Maria St, Laverton North, Vic 3026. Phone (03) 9369 8802; fax (03) 9369 8006.

High capacity rechargeable cells

Premier Batteries has introduced high capacity nickel metal hydride (NiMH) and nickel cadmium (NiCd) cells to their range. These nickel metal hydride cells are cadmium free and do not suffer from memory effect.

The increase in capacity allows for the AF and 4/3AF sizes to increase by 20% in capacity, thus providing 2400mA.H and 3800mA.H respectively. These cells are in constant demand in cellular phones and notebook computer packs where extended running time is a distinct advantage.

To keep pace, nickel cadmium cells are increasing in capacity at the same rate. AF is now available in 1700mA.H and 4/5AH to 1500mA.H.

Although capacities and technology are improving, prices have remained stable.

For further information, contact Premier Batteries Pty Ltd, 9/15 Childs Rd, Chipping Norton, NSW 2170. Phone (02) 9755 1845; fax (02) 9755 1354.

New kits from Dick Smith Electronics

Dick Smith Electronics have submitted two of their recent kits for SILICON CHIP projects for our inspection. They are the 5-Digit Tachometer from the October 1997 issue and the Heavy Duty 10A Motor Speed Controller from the November 1997 issue. Both conform closely to the SILICON CHIP prototypes and look quite professional in their presentation. The 5-Digit Tachometer has a screen printed front panel with the "window" being part of the artwork for a neat appearance.

The Speed Controller has had the lid of the diecast case linished for a better appearance and number of small refinements in the wiring. The most notable of these is the use of spring clip mounting for the IGBT and fast recovery diode which should reduce the possibility of breakdown to the case.

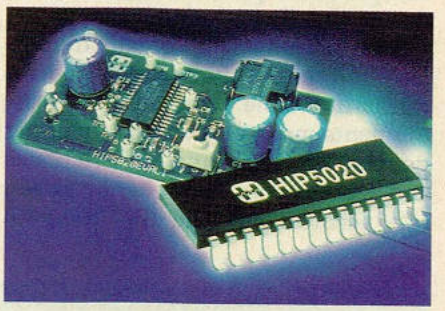
Both kits are available from Dick Smith Electronics stores across Australia and New Zealand.

Philips wireless speakers

Philips new mini sound system (model FW 780WPRO) features a wireless subwoofer and wireless surround speakers. With conventional audio systems there's always the problem of cables and where to hide them. But with this system, the audio signal is radiated on an FM carrier so the speakers are easy to install around the room for good surround sound.

The FW780WPRO also features Dolby Pro Logic sound, a three disc CD changer and audio/video remote control. The system retails for $1499.00 and is available from stockists around Australia.

Synchronous step-down converter



B.B.S. Electronics Australia has released Harris Semiconductor's HIP-5020 Buck Converter which steps down a DC battery voltage of 4.5V - 18V to a regulated system voltage of 3.3V or less and delivers up to 3.5A at greater than 90% efficiency.

The device integrates two Mosfets, a half-bridge driver and a 100kHz to 1MHz current mode pulse-width modulation (PWM) controller with current sense onto a single chip.

In order to assist design engineers using the HIP5020, Harris Semiconductors offers free simulation software. It provides realistic simulations that closely match lab results.

Miniature frequency counter with LCD

Aceco Electronics Corporation has released the FC2002 Handy Frequency Counter, which covers frequencies from 10Hz to 3GHz in a package around the same size as a cigarette box. It can display frequency and period and has " Advanced Auto Lock-out" which can be set to automatically detect and hold a signal reading.

The FC2002 has a backlit 10-digit liquid crystal display and incorporates a 16-segment RF signal bargraph and low battery indication. It has a switchable 50Ω/1MΩ input for the full 10Hz to 3GHz display range and the high speed 300MHz range features 0.1Hz resolution. A switchable filter prevents display of random noise.

The FC2002 has a sturdy stamped aluminium case with a black anodised finish. It is supplied with telescoping whip antenna and NiCd batteries to give up to 6 hours operation. For further information contact Computronics Corporation Ltd, Locked Bag 20, Bentley Business Centre, WA 6983. Phone (08) 9470 1177; fax (08) 9470 2844.

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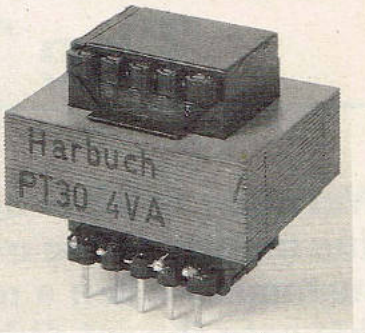


Manufactured in Australia
Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

The QuickDesign Simulation software is available from the Harris Semiconductor Internet site at http://www.semi.harris.com

For further information, contact B.B.S. Electronics Australia Pty Ltd, Unit 24, 5-7 Anella Ave, Castle Hill, NSW 2154. Phone (02) 9894 5244; fax (02) 9894 5266.

Hioki earth tester

The new Hioki 3151 Earth HiTester is a flexible instrument for making earth resistance tests. The instrument permits the use of the 'fall in potential' three-terminal method in which the E terminal is attached to the system ground electrode, the C (current) terminal to the furthest probe and the P (potential) to the roving probe.

In systems where the earthing electrode is extensive (eg, through the use of water pipes), the Hioki 3151 can be used in the two terminal mode, utilising the E and C terminals. Earth resistance is measured using the AC phase difference method to provide highly accurate measurements and two frequencies are available to the operator in order to eliminate the effects of circulating harmonic components.

For further information, contact Nilsen Technologies, 150 Oxford St, Collingwood, Vic 3066. Phone (03) 9419 9999; fax (03) 9416 1312; Freecall 1 800 623 350; Freefax 1 800 067 263.

New microcontroller from Parallax

Parallax have released their new SX-series 8-bit multi I/O controllers. They have an internal programmable 4MHz oscillator, three-level brownout reset, power on reset, a watchdog timer with its own RC oscillator, multi-input wake-up with optional interrupts and a flash EEPROM.

All of the SX I/O pins are multi-hardware compatible and can be programmed for input or output (sinking or source up to 30mA) or internal 20kΩ pullup resistors. Some pins may be configured as Schmitt trigger inputs, some as analog comparators and others as outputs with symmetrical drive.

For further information, contact the Australian stockist, Microzed Computers, PO Box 634, Armidale, NSW 2350. Phone (02) 6772 2777; fax (02) 6772 8987.

Flash electrolytics

Professional photographic flash equipment requires large high voltage aluminium electrolytic capacitors. They are used as a high voltage reservoir which is dumped into the flash tubes. High energy per unit volume, small dimensions and high flash frequency are the requirements.

Thanks to a specially devised anode film, flash electrolytics from Siemens exhibit an exceptionally high CV product.

The new flash electrolytics of the Siemens B43405, B43406 and B43407 series have rated voltages between 310 and 500V and capacitance from 120 to 17,000µF.

For further information, contact Malcolm Evans, Advanced Information Products, Siemens Ltd. Phone (03) 9420 7716; fax (03) 9420 7275; e-mail passive.comp@siemens.com.au **SC**

SERVICEMAN'S LOG

The TV set that smoked

Warranty work is not always plain sailing, due mainly to the over-reaction of some customers when a near-new set fails. And in this case the set didn't help matters much by first smoking and then working normally.

Mr and Mrs Clarke were not happy. Their nearly new NEC FS-5185 TV (MM-2 chassis PWC4034A) had thoroughly disgraced itself and had had the audacity to not only stop working but actually smoke in their living room. Anyway, the set was under warranty and though they would really have preferred a new set, they had to have it fixed straight away.

On these occasions, one has to be as polite and understanding as possible, whilst remaining aloof and firm as to what can and cannot be done under warranty.

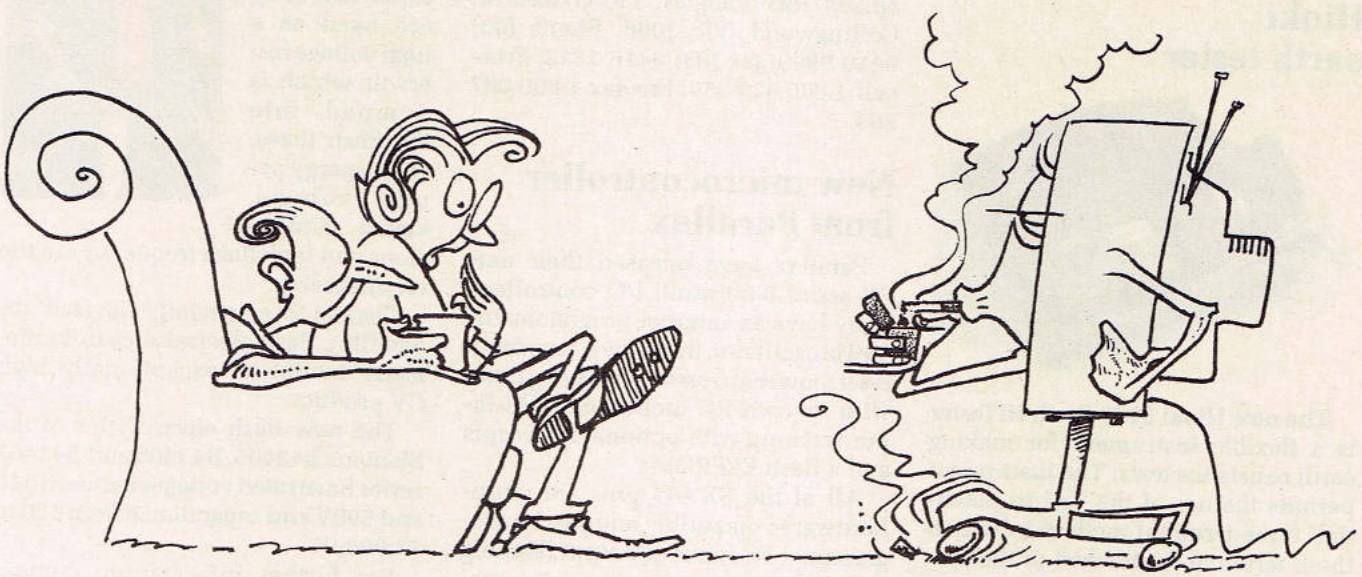
One way to reduce the acrimony is to attend to the problem as soon as possible. The set was actually under an extended warranty with a major department store, for which we are the service agents.

So it was with trepidation that I removed the back and had a good look around before connecting it up, switching it on and standing back. Well, what an anticlimax – the set came on and performed perfectly. What's more, when I examined the one-piece motherboard, I couldn't really determine any components that had burnt out at all. A number of resistors had got a bit warm and some of the white/clear glue the manufacturers now use to hold wires and components in place while they are soldered had melted, but really there was nothing to write home about.

I got onto the blower to report the situation to the Clarkes. They were not amused. Apparently "clouds of black smoke had come out of the set" and, what's more, they were definitely not going to have that set back their living room unless it was fixed properly. I went back and gloomily examined the hapless set once again.

First, I checked the HT rail and it was spot on 115V which is correct. Next I attacked the circuit board; I shook it, froze it and heated it and it kept right on going with a really good picture. I then put it aside on test and left it for three days. It didn't miss a beat.

I phoned the Clarkes again – "are you sure that the smoke came out of this set? Was it perhaps the VCR or the stereo system which are nearby? What about the power point? Does anyone in the family smoke?"



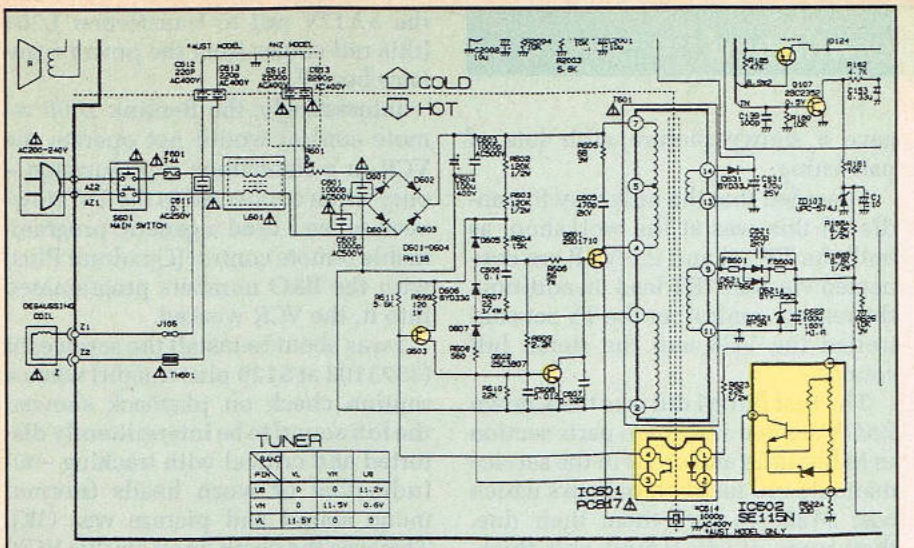


Fig.1: the power supply circuitry in the NEC FS-5185 TV set. IC602 (bottom, right) monitors the HT rail and drives optocoupler IC601 to derive a feedback control signal for chopper transistor Q601.

Mrs Clarke assured me that none of these had been the case.

I was perplexed but even after a week the set was still working perfectly and so I returned it to the less-than-understanding Clarkes.

The set bounces

It was nearly a fortnight later that the set bounced right back into the workshop with the same complaint. This time, fortunately, the fault was genuine – the set really was dead.

It didn't take long to establish that the 130V ZD621 R-2M safety zener diode was short circuit across the main HT rail. And for this to fail, it meant that the HT rail had risen above 130V. I replaced the diode and the set once more came on perfectly with the correct voltage. However, when I replaced the cabinet back and put it aside to test, the set was dead again.

Ah, ha, I thought. It must be a faulty back! But no; actually the zener had gone short circuit again.

Rather than risk yet another, I foolishly decided to run the set without it and initially all was OK. However, predictably, as soon as my back was turned, the B+ rose dramatically and wisps of smoke (but not a lot) came from numerous areas. This time, the line output transistor (Q502, 2SD2499) had gone, along with a couple of electrolytic capacitors (C313, C622). D631 had also failed by going short circuit.

After restoring everything, the voltage was constantly high and the set could only be run for a few seconds before the damage would re-occur. Because of this, I used a Variac and a lamp to keep the voltage down while I sussed the problem out.

My first suspects were IC602 (SE115N) and IC601 (a PC817 optocoupler) which are at the heart of the voltage control feedback network. Basically, IC602 monitors the HT rail derived from transformer T601 and drives optocoupler IC601 which in turn varies the drive to chopper transistor Q601 (2SD1710). I replaced both ICs and the associated 22kΩ resistor (R623) and resoldered everything in sight, in case a dry joint was lurking somewhere but to no avail.

In fact, the control feedback circuit of IC602 and IC601 was responding to voltage changes and I could see the mark-space ratio change on the collector of the 2SD1710 chopper transistor (Q601) as the Variac was altered. However, it refused to lock and there was no control of the secondary voltage rails.

Well, to cut a long story short, I was removing and checking every component on the primary ("hot") side of the chopper transformer when I noticed that the board had been slightly modified by the factory. Some of the PC board tracks had been cut and a number of components had been mounted on the print side of the board but the circuit was still the same as published by NEC.

A closer examination revealed that some of the parts on the component side around this area were rather awkwardly mounted and so I decided to remove these parts one by one for checking. When I desoldered one leg of R699 (120Ω, 1W), I noticed that the other leg simply fell away from the board.

In other words, one leg of this component had not gone right through the hole but was actually just touching the solder pod on the other side. The resistor checked out OK so I reinstalled it, this time making sure that both its leads were correctly soldered.

And that solved the problem. This time, when the Variac was wound up, the mark space ratio on the collector of Q601 became fixed when the HT reached 115V and the power supply was once again stable.

I soak tested the set for another week whilst fending off the ever-persistent Clarkes. I had, in fact, given them a loan set when the problem re-emerged but it is the nature of some customers to be impatient.

The set was eventually returned but the Clarkes remained totally unimpressed with my efforts to help them. You win some and you lose some.

The Beovision gear

Bang and Olufsen, or B&O, are among the "Rolls Royce" brands when it comes to producing home entertainment equipment and this is reflected by their prices. Their products are beautiful to look at, even when switched off, and their performance is definitely up-market – all of which you would expect for the prices demanded for this luxury equipment.

B&O has been quite innovative with some of their technology over the years and often have neat little features built into their equipment; eg, wave your hand in front of the CD player and the drawer will open! Their Beolink system, which allows you to have different selected music in every room of your house, was one of the first designs of this nature.

On more familiar turf, their TV sets introduced automatic grey scale adjustment years ago. And of course they have an amazing ability to cram electronics into very thin, unobtrusive cabinets with hardly any wires protruding.

But I digress – I am beginning to

sound rather like one of their salespersons.

Mrs Smythe-Jones was from the old country and lived in an exclusive suburb along with her pedigree Siamese cats and of course, her Beovision Type 3854 2502 stereo TV, her Beocord VHS91 type 4493 VCR and her Beolink 1000 hifi system. These approximately 10-year old items had been reinstalled by B&O when she arrived some years ago and now, because of their age, they were beginning to show signs of trouble.

How much is it?

Despite her obvious affluence (or perhaps because of it), she immediately enquired about the price of servicing the equipment and wasn't too impressed with my answers. However, she was in too deep with her investment in B&O and so, reluctantly, she instructed me to go ahead and sort out the problems.

Living in an exclusive suburb does have its drawbacks, one of them being poor TV reception due to the tall trees that characterise the area. Installing a separate high-performance UHF antenna certainly improved things a lot but her main complaint was poor reception through the Beocord hifi video recorder. In particular, she complained about the picture which had a vertical line down the screen about 5cm from the lefthand side. And the video tuner gave a snowy picture with lots of patterning.

I decided that the only way to handle all this was at the workshop, as both the TV set and the VCR are connected via a SCART lead. In addition, the remote control for the TV set controlled the VCR and the stereo hifi sound.

The first thing I did was track down B&O's service and spare parts section in Melbourne and order in the service manuals and instruction books which cost $120. To give them their due, they were nicely bound and thick. Unfortunately, what ever they gained in presentation they lacked in detailed substance. For example, there was no circuit description and no PC board component layout diagram for the TV set although there was for the VCR. As it turned out, the latter was made by Hitachi for B&O and is similar to a 1986 VT-860E(AU).

The B&O service manager was very helpful and suggested various courses of action, including fitting the various service/modification kits.

I started with the Beocord VCR which I connected to a different TV and tuned in on approximately Ch37. The patterning and snow was easily fixed by replacing the electrolytic capacitors (as was suggested) in the inverter power supply on the VS tuning board. The main culprit here appears to be C715 (100µF, 25V) which is on the +A17V rail to transformer L701 (this rail comes from the power regulator board).

Interestingly, the Beolink 1000 remote control would not operate the VCR in a standalone configuration – only when connected to the TV. However, when I used a generic programmable remote control (Quadrant Plus) with the B&O numbers programmed into it, the VCR worked.

I was about to install the service kit (3375102 at $129 plus freight) when a routine check on playback showed the hifi sound to be intermittently distorted and critical with tracking – all indicative of worn heads (normal mono sound and picture was OK). This was the death knell for this VCR, as the heads (8600097) cost a cool $600 trade price.

It was too hard to work out the equivalent Hitachi part number and the risk that it wouldn't work properly was too high. B&O advised us that the unit was too old to repair anyway and that we shouldn't proceed.

The TV set

So it was on to the TV set, with the problem described as "curly beads" (the aforementioned speckled line down the screen about 5cm from the lefthand side). This is usually due to parasitic oscillation in the line output stage and can be fixed in most cases by fitting a ferrite bead or two to the emitter of the line output transistor.

B&O had not heard of this problem in their sets before but suggested we install their service kit 3390454, which prevents failure of the line output transistor (4TR11). An S2000A was fitted here but a BU508 is shown on the circuit diagram. The kit of 10 components cost $30 plus freight and included a BU508A replacement transistor. A ferrite bead (FE1) was already installed in the set.

It was all fairly straightforward to fit, the only exception being PNP transistor 4TR15. This was originally a BC328-25 but the replacement was a BC369 which has a different pin arrangement (bce instead of ebc).

Wrong leads

You guessed it – in the melee of installing this and soldering any suspicious-looking joints, I inadvertently connected its collector and emitter leads around the wrong way. When I

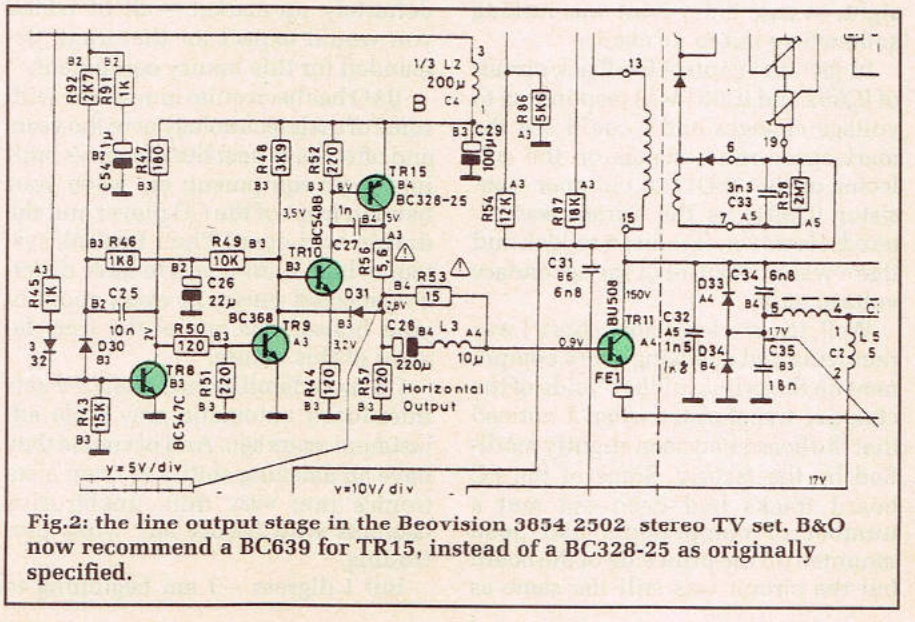
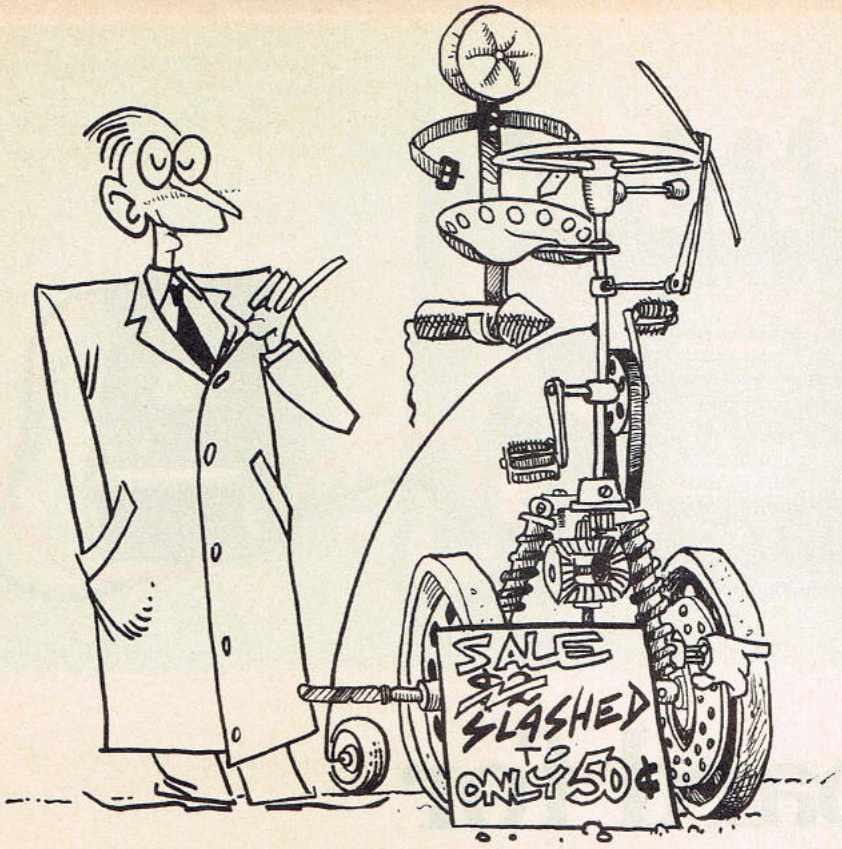


Fig.2: the line output stage in the Beovision 3854 2502 stereo TV set. B&O now recommend a BC639 for TR15, instead of a BC328-25 as originally specified.



AN ENGINEER IS SOMEONE WHO CAN DESIGN SOMETHING FOR 50 CENTS THAT ANY DAMN FOOL CAN MAKE FOR 2 BUCKS.

switched the set on afterwards, the picture was perfect and the "curly beads" were gone.

It was only when I was checking my work and cleaning up afterwards that I realised my mistake and quickly corrected it, only to find that the fault was back. I double-checked everything to confirm that it was all as per the instructions and even fitted another BC369 I had in stock (without result) before phoning B&O for clarification.

To cut a long story short, I was told that I shouldn't use a generic substitute as all B&O components are carefully selected for optimum performance – in this case for its "slew switching rate". I was also told that they had done this modification lots of times and that I was extremely lucky I hadn't blown the line output transistor.

Suitably humbled, I delicately asked if I could have a genuine B&O selected BC369 (PH72) – to give it its full title – to replace the original BC328-25 PH27. The manager kindly agreed to send me out one free of charge. In the meantime, I decided to give the board a good going over by resoldering any suspicious joints. I also spent some time cleaning the board and cleaned and lubricated around the ultor cap.

A few days later, I received not one but two BC328-28 PH27s instead of the specified BC369 PH72. Anyway, I fitted one of them and the picture was back to normal. As an experiment, I then refitted the original transistor only to find that it too now worked perfectly.

More questions than answers

Well, despite fixing the problem, this left more questions than answers. First, which component or components fixed the fault? I replaced the originals and undid any modifications to try to find out but it made no difference. I now think that the problem could have been caused either by a dry joint, by sparking where the ultor cap connects to the tube, or by sparking at the CRT socket. In the process of cleaning, soldering and lubricating everything, I had inadvertently fixed the problem.

I remain unconvinced of the necessity for highly graded components, as the original line output transistor had not failed in 10 years and it showed no signs of stress, even with the collector and emitter leads of 4TR15 reversed. Besides, I was always told that a well-designed circuit should operate with any generic component.

Doesn't the saying go something like this? – "an engineer is someone who can design something for five bob that any damn fool can make for a quid".

I refitted the service kit again – after all, it had been paid for – and put it aside to soak test. We abandoned the VCR and sold Mrs Smythe-Jones a new Loewe-Opta hifi unit which did everything and more than the original did except use the Beolink 1000 remote control system. **SC**

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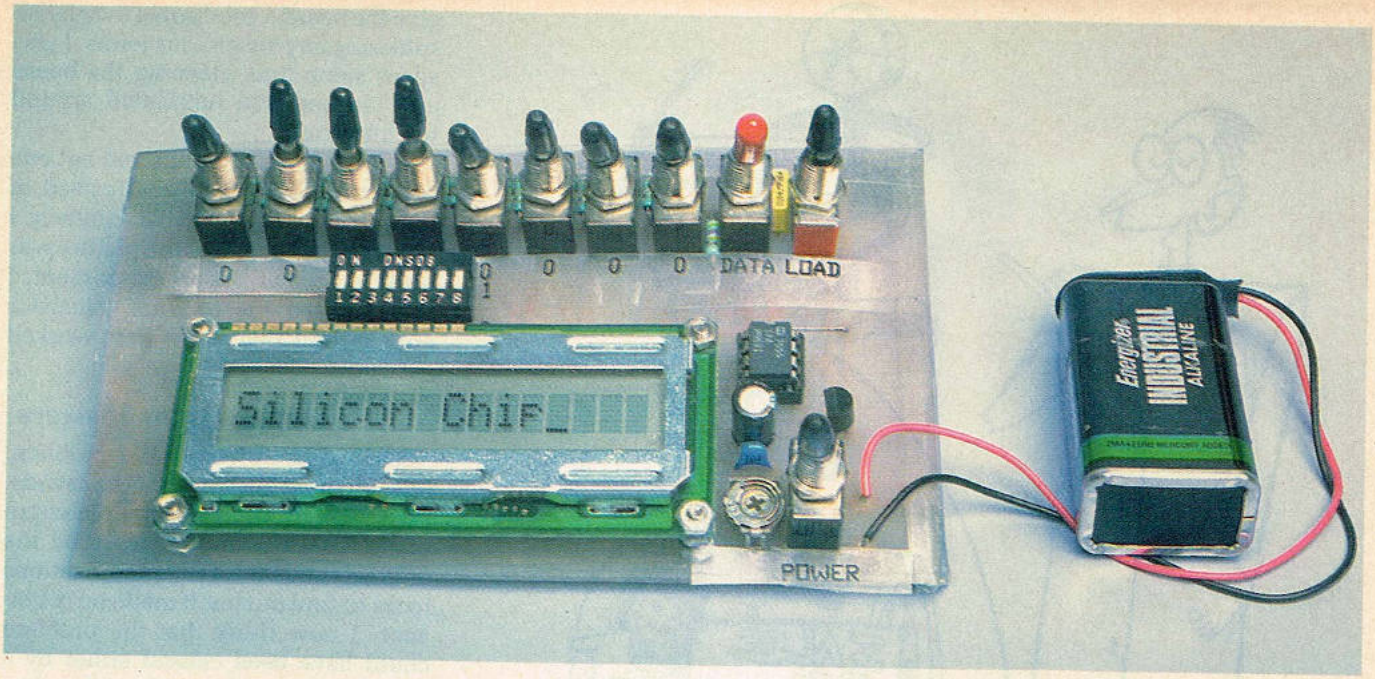


Demo board for liquid crystal displays

Ever wondered how an alphanumeric liquid crystal display translates digital data into a readable message? Then wonder no more and build this neat little demo project which uses a one-line alphanumeric LCD.

By RICK WALTERS

These days almost every electronic doodad seems to have an LCD in it. From those horrible little Tamagochi hand games to the ubiquitous bat phone (What? You still call yours a mobile?) to photocopiers and faxes, they're everywhere. However did we function without LCDs? Maybe life was simpler then . . .

Anyway, how do these LCDs work? Most LCDs are not just the bare liquid crystal display with a whole bunch of connections made via an elastomeric connector to an external circuit. Instead, most one and two-line alphanumeric displays have a processor encapsulated in a blob of black plastic on the back. Alternatively, the processor might be a surface mount device on the back of the display.

Either way, the principle of operation is much the same. Parallel 8-bit data is fed in on a bus and this is converted by the processor to be displayed.

Before we go any further, we had better define what we mean by "alphanumeric". This merely means that the display can handle alphabetic and numeric characters; ie, numbers and letters. More to the point, most alphanumeric displays can handle most of the 256 characters possible in the ASCII character set.

Typically they can display all upper case and most lower case letters, numbers, punctuation marks, mathematics symbols such as plus, minus, division, percentage, greater than, less than and so on, some Greek symbols, the dollar sign, asterisk, hash and perhaps some Kanji symbols from the Japanese language.

For this demo project we have used an LCD employing the very common Hitachi HD44780 LCD controller chip. It converts the 8-bit data into characters employing a 8 x 5 dot matrix. This same dot matrix, by the way, is used in cheap dot matrix printers. Obviously then, the on-board processor does a translation (decode) between 8-bit ASCII characters to an 8 x 5 dot matrix display, as well as providing the buffer to display a full line of characters.

As you can see, the demo project

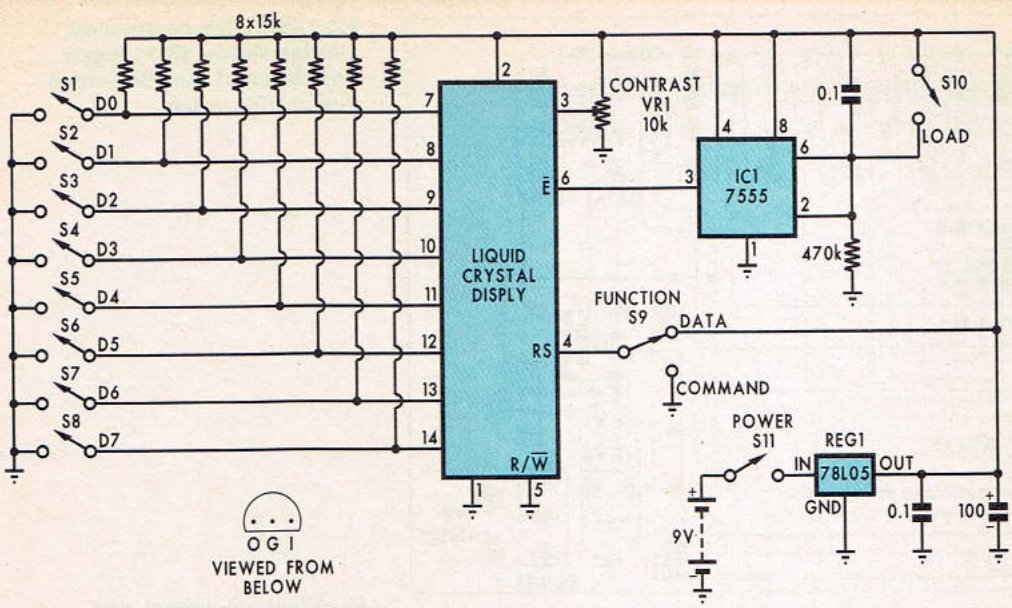


Fig.1: the circuit uses eight switches to load binary data into the LCD controller. IC1 is used to debounce the LOAD switch S10.

MANUAL LIQUID CRYSTAL DISPLAY

consists of the chosen LCD panel together with a row of 10 switches on it. Eight of the switches are for setting the 8-bit data, while the other two are for actually loading the data into the display. There are some other bits on the board as well but we'll come to those later.

Now you might think at this stage that this project is not all that practical, particularly if you are thinking of loading in long messages by hand! You'd have to be working all those switches like a veritable whirlwind if the message was to be displayed in a reasonable time. No, that is not the purpose of the project. It is merely a learning tool which will give you some knowledge of how ASCII characters are displayed onto an 8 x 5 matrix.

It will also be useful if you are beginning to write software to drive a display with a microprocessor or the parallel port of a computer, as it allows you to check that the function you are coding does actually work as intended.

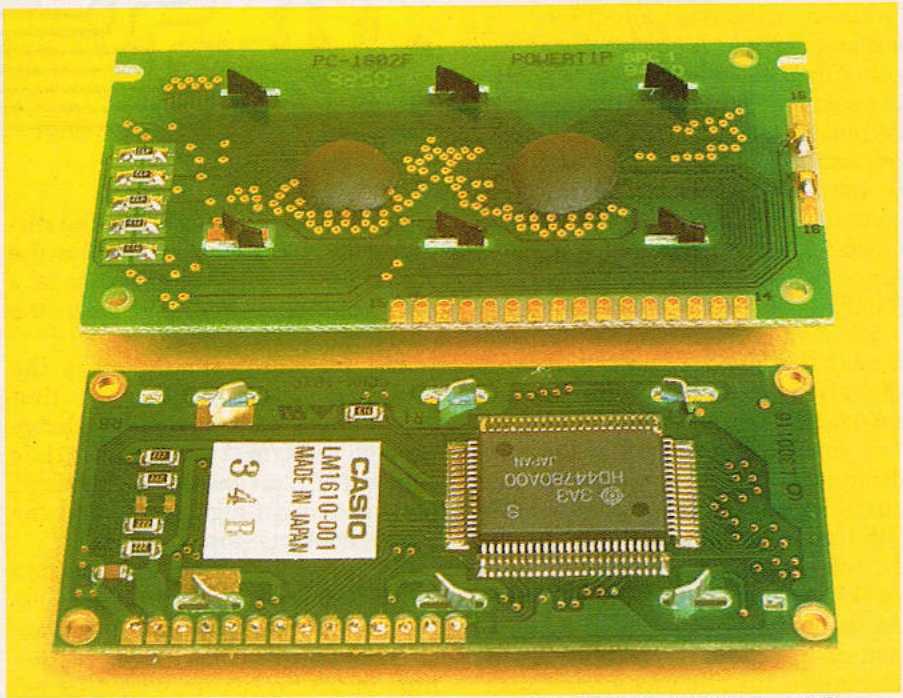
As you can see from the circuit of Fig.1, apart from the switches and the LCD panel itself, there are a few resistors, three capacitors, a voltage regulator, a 7555 CMOS timer and a battery to get the display working.

Keen-eyed readers will have also noticed an 8-way DIP switch on the board but that is there as a cheap alternative to the individual toggle switches. The DIP switches are more difficult to use if you want to load in a lot of data but they could be a practical alternative if you envisage using this project just to display one message. As I am writing this article I am absolutely devoid of ideas on what such a message might be, but I am equally sure there will be heap of uses out there.

Mind you, there are two drawbacks to using the 8-way DIP switch to replace the logic level input switches S1-S8. For a start, the DIP switches are much more difficult to set. Second, the data must be entered backwards as the most significant bit is on righthand side of the switch, whereas binary numbers are conventionally written from left to right with the most significant bit on the left. Makes it a bit tricky, eh?

On the other hand, some readers seem to thrive on a challenge.

For those readers who want the easier life, the conventional toggle



This photograph shows the old display at top with the "black blobs" and the new display with the HD44780.

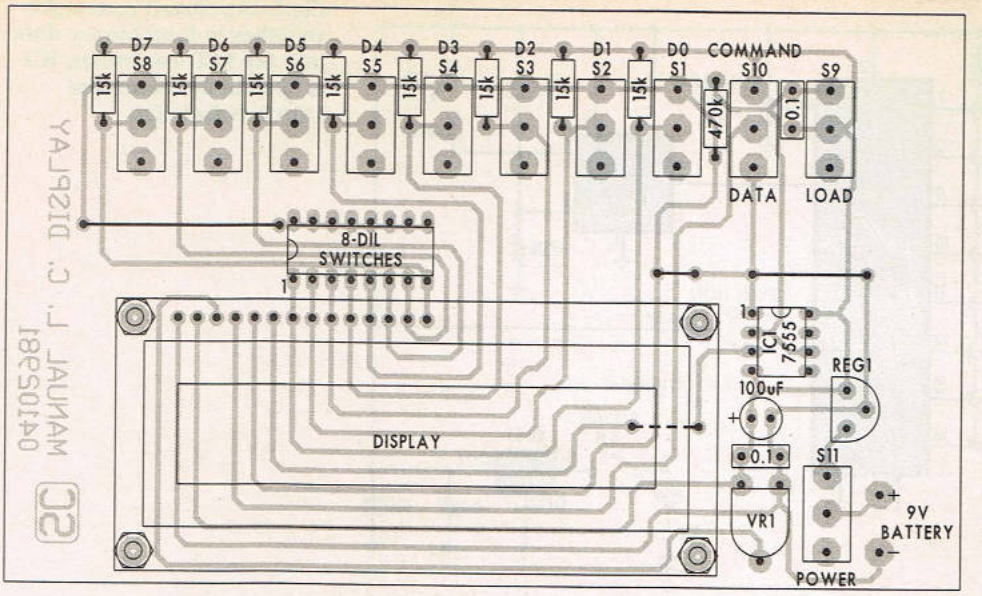
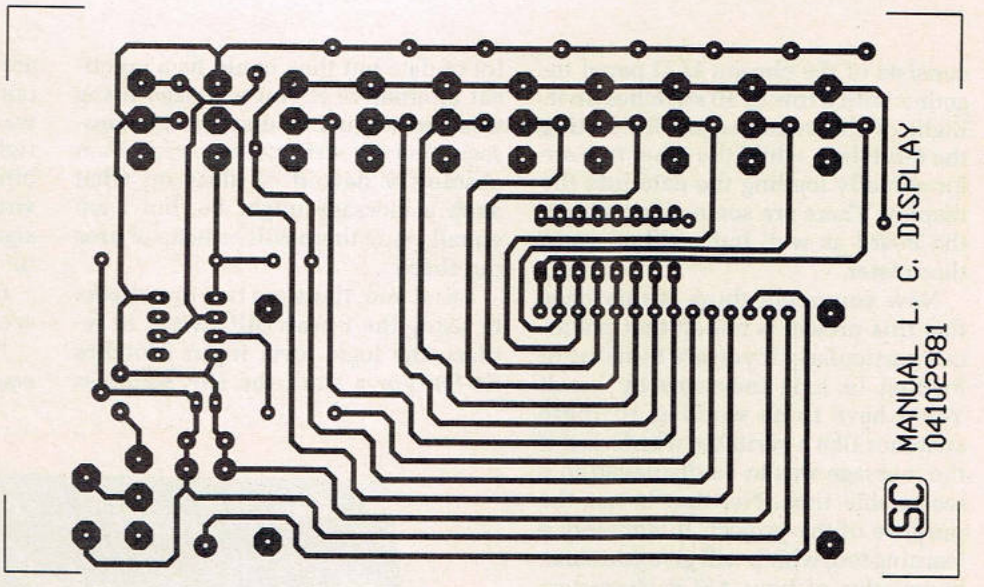


Fig.2 (left): the component overlay shows all 11 toggle switches and the alternative 8-way DIP switch.

Fig.3 (below): actual size artwork for the PC board.



switches are laid out to accept conventional data.

How it works

There are two types of information which the controller chip can accept: commands and data. A command is an instruction which tells the controller to do something internally, such as set an 8 or 16-character display, home the cursor, clear the display etc. Data consists of the character or characters we wish to show in the display window.

These instructions are differentiated by the logic level on pin 4 (register select). This pin is taken low (ground) to input a command and high (5V) to input data. The value of the input is set, in 8-bit binary, by the switches D0 to D7 (or the DIP switch). Once the value is entered it is transferred to the display by taking pin 6 (enable) low.

So what is the reason for the 7555 timer IC? Why not connect the switch directly to pin 6 of the display and save on the cost?

If you did this you would be very disappointed with the result. The first character you entered would probably fill the entire display due to the switch's contact bounce. When a switch is actuated it never just closes. As the contacts make, their momentum causes them to "bounce" apart, then make, then bounce.

This can continue for 30ms or so. When you turn on a light or a jug, the bounce doesn't matter but as the display only takes 40µs to process the instruction, it sees each bounce as a new instruction and will write the character over and over.

The capacitor fitted across the switch is discharged on the first "make" and cannot rapidly charge through the 470kΩ resistor. This time constant of 47ms ensures that the logic level cannot go high again until the switch contacts stop bouncing.

OK but why use the 7555? Couldn't the junction of the resistor and capacitor go directly to pin 6? The answer is yes but then the transition time of the waveform would be too slow around the switching threshold of the HD44780 and there is the possibility of at least two characters being written.

The IC output has very fast rise and fall times which are more suited to the display characteristics. Don't forget, the display was designed to be driven from a microprocessor.

Pin 5, the read/write pin, is tied permanently low as, with this simple setup, we cannot read information from the display.

VR1, the 10kΩ contrast control, is necessary as its optimum setting varies depending on the display length, duty cycle or character mode. We'll talk more about this aspect later.

Building the PC board

The first step is to check the PC

Table 1: HD44780 Instructions

Instruction	Code RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description	Execution Time (max) (when f_{cp} or f_{osc} is 270 kHz)
Clear display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DDRAM address 0 in address counter.	
Return home	0	0	0	0	0	0	0	0	1	—	Sets DDRAM address 0 in address counter. Also returns display from being shifted to original position. DDRAM contents remain unchanged.	1.52 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	37 µs
Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets entire display (D) on/off, cursor on/off (C), and blinking of cursor position character (B).	37 µs
Cursor or display shift	0	0	0	0	0	1	S/C	R/L	—	—	Moves cursor and shifts display without changing DDRAM contents.	37 µs
Function set	0	0	0	0	1	DL	N	F	—	—	Sets interface data length (DL), number of display lines (N), and character font (F).	37 µs
Set CGRAM address	0	0	0	1	ACG	ACG	ACG	ACG	ACG	ACG	Sets CGRAM address. CGRAM data is sent and received after this setting.	37 µs
Set DDRAM address	0	0	1	ADD	ADD	ADD	ADD	ADD	ADD	ADD	Sets DDRAM address. DDRAM data is sent and received after this setting.	37 µs
Read busy flag & address	0	1	BF	AC	AC	AC	AC	AC	AC	AC	Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0 µs
Write data to CG or DDRAM	1	0	Write data								Writes data into DDRAM or CGRAM.	37 µs t_{ADD} = 4 µs*
Read data from CG or DDRAM	1	1	Read data								Reads data from DDRAM or CGRAM.	37 µs t_{ADD} = 4 µs*

I/D = 1: Increment
I/D = 0: Decrement
S = 1: Accompanies display shift
S/C = 1: Display shift
S/C = 0: Cursor move
R/L = 1: Shift to the right
R/L = 0: Shift to the left
DL = 1: 8 bits, DL = 0: 4 bits
N = 1: 2 lines, N = 0: 1 line
F = 1: 5 × 10 dots, F = 0: 5 × 8 dots
BF = 1: Internally operating
BF = 0: Instructions acceptable

DDRAM: Display data RAM
CGRAM: Character generator RAM
ACG: CGRAM address
ADD: DDRAM address (corresponds to cursor address)
AC: Address counter used for both DD and CGRAM addresses

Execution time changes when frequency changes
Example:
When f_{cp} or f_{osc} is 250 kHz,
$37\ \mu s \times \frac{270}{250} = 40\ \mu s$

Note: — indicates no effect.

* After execution of the CGRAM/DDRAM data write or read instruction, the RAM address counter is incremented or decremented by 1. The RAM address counter is updated after the busy flag turns off. In Figure 10, t_{ADD} is the time elapsed after the busy flag turns off until the address counter is updated.

pattern against the artwork of Fig.3, ensuring that the tracks between the switch pads don't short and that none of the tracks are broken. Any necessary repairs should be done now.

To keep the cost low we have screened the switch information on the top of the PC board as there seems little point in putting it all in a case.

The first step is to fit and solder the four links as shown on the component overlay diagram of Fig.2.

Next, fit and solder the resistors, trimpot, IC, capacitors, pin header, regulator, battery clip, then lastly the switches, making sure that the spring-loaded toggle is fitted at the righthand end of the board and the switch action is towards the 7555 timer. The centre pin of the regulator will have to be bent away from the flat to fit the PC board.

We have specified a 14-pin strip to connect the display pins to the PC board. There is no need to solder the pins to the display board – just bend them slightly so that each makes good contact with its respective gold-plated contact. This approach allows you to easily remove the display and use it in other projects. You will need to check continuity from each pin to the display pad to ensure that they are all making contact.

Check that the polarity of the electrolytic capacitor is correct and that the DIP switch is fitted facing the right direction. Also double check that the battery leads are soldered into the correct pads before you connect the battery.

Lastly, fit a self-adhesive foot to each corner of the PC board to prevent it from sliding around while you are setting the switches and also to protect any surface it may be placed on.

Testing the display

Turn the contrast control VR1 fully anticlockwise, plug in the battery and turn the power on. Eight dark rectangles should show at the left half of the display. When power is applied the controller initialises an eight character display and these are what you can see. The contrast control should now be turned clockwise until these rectangles just disappear.

Before we can do any further testing we need to give just a short burst on binary numbers. We are all used to dealing with decimal (power of 10) numbers which have 10 digits (0-9). As the name suggests, binary (power of two) numbers have just two digits (0 & 1). We use the switches S1-S8 to select either of these values, a zero being a low logic level and a one being a high logic level.

There are eight input switches, so to define the position of each switch

Table 2: Character Codes vs. Character Patterns

Lower 4 Bits \ Upper 4 Bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)			0	@	P	`	p				ー	タ	ミ	α	p
xxxx0001	(2)		!	1	A	Q	a	q			。	ア	チ	ム	ä	q
xxxx0010	(3)		"	2	B	R	b	r			「	イ	ツ	メ	ß	θ
xxxx0011	(4)		#	3	C	S	c	s			」	ウ	テ	モ	ε	∞
xxxx0100	(5)		$	4	D	T	d	t			、	エ	ト	ヤ	μ	Ω
xxxx0101	(6)		%	5	E	U	e	u			・	オ	ナ	ユ	σ	ü
xxxx0110	(7)		&	6	F	V	f	v			ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)		'	7	G	W	g	w			ァ	キ	ヌ	ラ	g	π
xxxx1000	(1)		(	8	H	X	h	x			ィ	ク	ネ	リ	√	x̄
xxxx1001	(2)		)	9	I	Y	i	y			ゥ	ケ	ノ	ル	⁻¹	y
xxxx1010	(3)		*	:	J	Z	j	z			ェ	コ	ハ	レ	j	千
xxxx1011	(4)		+	;	K	[	k	{			ォ	サ	ヒ	ロ	ˣ	万
xxxx1100	(5)		,	<	L	¥	l	|			ャ	シ	フ	ワ	¢	円
xxxx1101	(6)		−	=	M	]	m	}			ュ	ス	ヘ	ン	£	÷
xxxx1110	(7)		.	>	N	^	n	→			ョ	セ	ホ	゛	ñ	
xxxx1111	(8)		/	?	O	_	o	←			ッ	ソ	マ	°	ö	

(hence each input instruction) we issue a string of eight binary digits (or bits), always starting with bit 8.

For example, the command for 'turn display and cursor on, with cursor position underlined' is 00001110. This means S1 and S5-S8 would be turned off (down) while S2, S3 and S4 would be turned on (up). This was done to match the DIP switch which is up for on.

All the commands are shown in Table 1. As it is quite difficult to speak and think in binary, most people prefer to use decimal, or if you are a computer boffin, then you must talk Hexadecimal (power of 16) which uses the digits 0-9, then A-F for the next six. The table also shows these values.

Now back to the testing. If you set the switches to 00001110, the function switch to command (CMD) and actuate the LOAD switch, an underline will appear at the first position. So the code actually worked. If you are using the DIP switch 2, 3 and 4 would be ON, the rest OFF.

OK, now let's do something a little more useful and enter some data. The fist step is to switch S9 from command to data. Keeping it simple, we will enter the characters A-P. The 8 bits for each letter of the alphabet, as well as all the characters the display is capable of, are shown in Table 2. Set the capital A, 01000001, and load it with S10. Hopefully an A will display and the cursor will step to the next position. Continue to enter the letters. What happened to I? A 16-character display with only eight characters is not much use.

This is the difference between early displays similar to the one used in the SILICON CHIP article in May 1993, which had a continuous address space for the sixteen characters. The old style displays (see photo) had two black blobs on the PC board, which have been replaced by the HD447870. Unfortunately, but for compatibility reasons, it has the addresses of the first eight characters from 0 to 8 but the second eight characters from 64 to 71 decimal (40H to 47H).

Now let's try again. We must set the display for 16 characters. Set the switches for 00111000, the function switch to command and load the instruction. The contrast control will need to be reset slightly for optimum viewing as the duty cycle has changed. Load 00000001 to home the cursor and clear the screen, then change to data and begin loading the alphabet again.

This time after you load H the cursor will disappear. Using COMMAND and 01000000 will restore the cursor, but when you try to enter characters the cursor steps but writes blanks. Use 01000000 and command to bring it back to position 9 then load command 11000000. Now when you continue entering the alphabet all is well.

Look up these last two commands in Table 1 to see what they actually did.

Table 3: User Designed Character

Binary	Decimal	Hex
0000 1110	14	E
0000 0000	0	0
0001 1011	27	1B
0000 0100	4	4
0000 0100	4	4
0001 0001	17	11
0000 1010	10	A
0000 0100	4	4

Moving the text

Up until now we have stepped the cursor forward each time we entered a character but it is also possible to keep the cursor stationary and move the text either to the left or to the right. Again from Table 1, the command for "shift left" is 000011000 and "shift right" is 00011100.

As we saw previously, if you enter more than eight characters starting from position 1, they don't appear on

the display. They are still being stored in RAM though and can be moved backwards and forwards in the display window by using either of the above instructions in command mode and loading it. Try it for yourself.

The only thing left to do now is to create our own symbols. Up to 16 custom symbols can be stored in CGRAM but they must be loaded each time the display is powered up. This is because they are stored in static RAM and they are lost when power is removed. If you were using a micro it would be easy to load them at each power up.

Symbol creation

If you look closely at the display, with the contrast adjusted to see the black rectangles, you will observe that the characters are made up using an 8 high by 5 wide dot matrix. Each of these dots (pixels) is addressable and this is why we can create our own symbol.

To program a symbol the first step is to draw it on the righthand side of an 8 by 8 grid (see Table 3). The lefthand three digits are always zeros. The choice is limited but we shall draw a crude smiley face. Clear and home the display then set the address to 01000000 and load it. Change to character and load the eight binary numbers starting from the top (00001110).

After the eighth has been entered, switch to command and clear the display. Switch back to data and write 01000001 which should be a capital A (just to check everything is still working), then write 00000000 which will display our face. The first saved symbol is stored in location zero (even though we wrote it at position 64, and the next fifteen are saved in locations 1 to 15. This is shown in Table 2.

Well, that covers the capabilities of this simple display. It can't show 10 by 5 or true lower case characters, but the knowledge you have gained will apply to multi-line and 10 x 5 displays.

Computer control

Next month, we will use this same LCD panel in a project which can be driven from a PC's parallel port. It won't be so much of a learning experience but it is a heck of a lot quicker to get a readable message. **SC**

Parts List

1 PC board, code 04102981, 127 x 77mm
1 one-line Liquid Crystal Display with HD44780 controller
10 SPDT toggle switches **or**
2 SPDT toggle switches and
1 8-way DIP switch (see text)
1 SPST spring-loaded toggle switch (S10)
1 78L05 5V regulator
1 9V battery
1 battery snap connector
1 14-way pin strip
4 2.5 x 15mm machine screws
12 2.5 mm nuts
4 12 x 12mm adhesive rubber feet

Capacitors
1 100µF 16WV PC electrolytic
1 0.1µF MKT polyester
1 0.1µF monolithic ceramic

Resistors (0.25W, 1%)
1 470kΩ
8 15kΩ
1 20kΩ PC trimpot (VR1)

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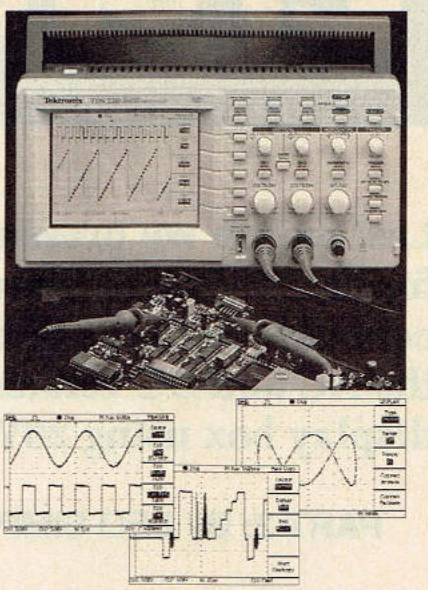

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Last month we presented the circuit details for the 12V Light Show and this month we conclude with the constructional details for the AC and DC versions, as well as a light display box using 20W halogen lamps.

PART 2: By LEO SIMPSON & RICK WALTERS

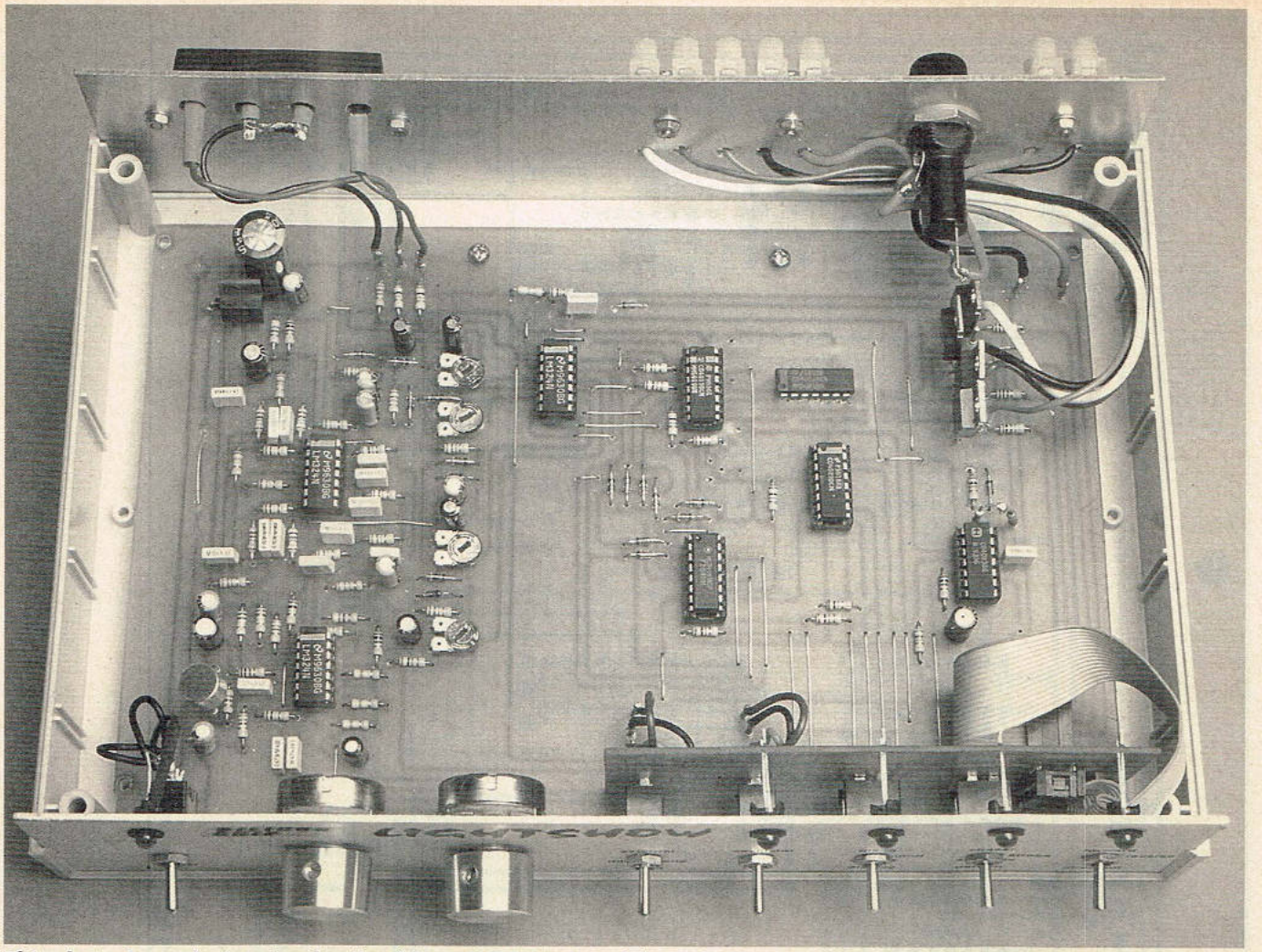
The Light Show is mounted in a plastic instrument case which measures 260 x 180 x 65mm. Inside there are two PC boards, the main board measuring 236 x 160mm (code 01112971) and the smaller front panel board measuring 120 x 49mm. The front panel board is mounted vertically behind the front panel (funnily enough) and is secured to the panel by the mounting bushes of the six miniature toggle switches.

There are quite a few connections between the main PC board and the front panel board and these are taken care of by six wires to the Input (S1) and Beat (S5) switches and a 16-way cable between header sockets on both boards.

Board assembly

Let's talk about the front panel board first since it is the easiest to assemble. Its component overlay is shown in Fig.1. First, mount the switches on the board. Their lugs are inserted from the component side and soldered. Make sure that each switch is sitting perpendicular to the board before soldering the lugs.

That done, insert the 16-pin socket for the cable header and solder it in place. Next, insert and solder the four red LEDs. These should be mounted



This photo shows the interior details of the 12V DC version of the Light Show. Note the position of the red strip on the 16-way ribbon cable that's used to connect the switch board to the main PC board.

with their full lead length so that they stand about 15mm above the board. This enables them to fit easily into the bezels on the front panel. That part comes later.

The next part is tricky and involves making the 16-way header cable.

Terminating the ribbon cable

While most kitset suppliers will probably include an assembled header cable, you will certainly need to make it if you are not building this project from a kit. The easiest way, if you don't have a crimping tool, is to plug the header into the extra 16-pin IC socket (specified in the parts list), then feed the cable into the top of the header. The assembly can now be carefully squeezed together in a vice, making sure the ribbon is sitting flat and square in the header. You will squash the pins in the socket and it may snap but don't worry, it will still work when you crimp the other end of the cable.

The 16-way grey ribbon cable we used comes with a red stripe on one side and this should be aligned with the pin 1 end of the header at both ends. You can confirm this by looking at the photos in this article.

Having passed this hurdle, it is time to move onto the more straightforward assembly of the main PC board. Its component overlay is shown in Fig.2. First check the bare board for any undrilled holes, broken tracks, shorts between tracks or evidence of thermonuclear damage before installing any components. Fix any defects and check that the two small cutouts at

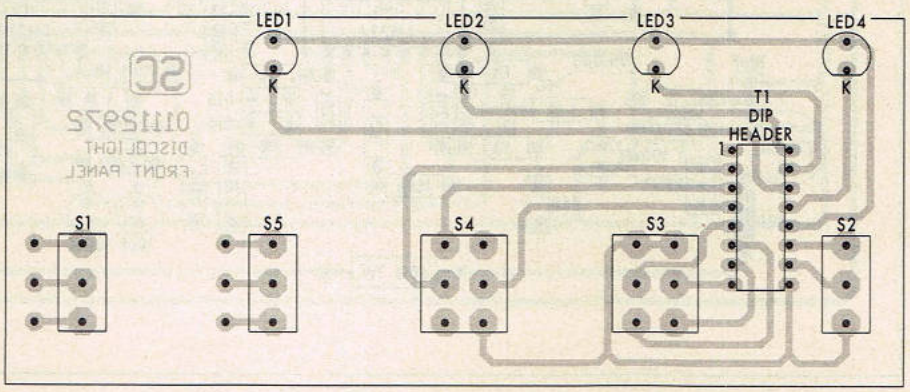


Fig.1: component overlay for the front panel PC board.

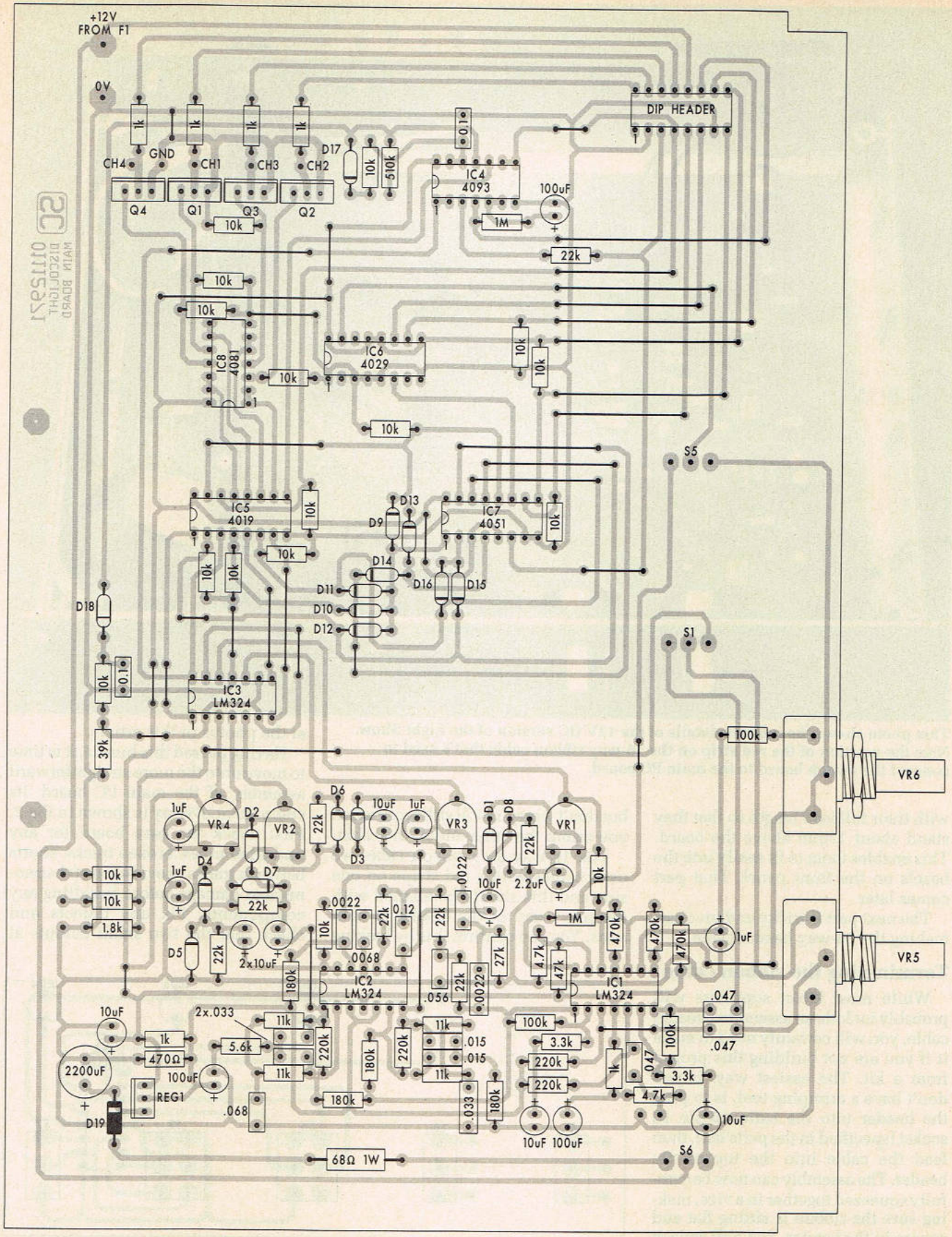


Fig.2: component overlay for the main PC board. Take care to ensure that all polarised parts are correctly mounted.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	1MΩ	brown black green brown	brown black black yellow brown
❑	1	510kΩ	green brown yellow brown	green brown black orange brown
❑	3	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	4	220kΩ	red red yellow brown	red red black orange brown
❑	3	180kΩ	brown grey yellow brown	brown grey black orange brown
❑	3	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	39kΩ	orange white orange brown	orange white black red brown
❑	1	27kΩ	red violet orange brown	red violet black red brown
❑	8	22kΩ	red red orange brown	red red black red brown
❑	1	18kΩ	brown grey orange brown	brown grey black red brown
❑	4	11kΩ	brown brown orange brown	brown brown black red brown
❑	18	10kΩ	brown black orange brown	brown black black red brown
❑	2	5.6kΩ	green blue red brown	green blue black brown brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1.8kΩ	brown grey red brown	brown grey black brown brown
❑	6	1kΩ	brown black red brown	brown black black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	68Ω	blue grey black brown	blue grey black gold brown

each end of the board have been made to allow it to clear the front pillars in the case. Then proceed by fitting and soldering the 36 wire links and 17 PC pins.

These can be followed by the diodes, resistors, IC sockets and trimpots. Then insert the capacitors, making sure that all the electrolytics are installed with the correct polarity.

Note the 68Ω 1W resistor on the lefthand edge of the PC board. This is only required if you are building the circuit for AC operation; ie, with a 12V transformer powered from the 240VAC mains. If you are building the Light Show to be powered from a 12V battery, the 68Ω resistor can be omitted and a wire link fitted instead.

The electret microphone insert is wired directly to two PC stakes on the board. No shielded cable is necessary.

The four Mosfets (Q1-Q4) are mounted in a straight line and require no heatsinks.

Lastly, mount the two potentiometers (VR5 & VR6) on the PC board.

Case assembly

We will assume that you are building a kit which has the front and rear panels already drilled for you. If not, you will have to use the front panel artwork (Fig.8) as a drilling template before assembly can proceed.

The first step is to attach the front panel to the two potentiometers on the main board, using the pot nuts and washers. Solder one of the headers of the 16-way cable to the socket position on the front panel board (note: no socket is actually fitted in this position). Make sure that the red stripe of the cable is closest to the LEDs. Then attach the board to the front panel using the six toggle switches as the anchor points. You will need to use spacer nuts on the switch bushes so that the four LEDs protrude through their respective bezels by the right amount.

Table 2: Capacitor Codes

❑	Value	IEC Code	EIA Code
❑	0.12µF	120n	124
❑	0.1µF	100n	104
❑	.068µF	68n	683
❑	.056µF	56n	563
❑	.047µF	47n	473
❑	.033µF	33n	333
❑	.022µF	22n	223
❑	.015µF	15n	153
❑	.0068µF	6n8	682
❑	.0022µF	2n2	222

Then attach the free end of the 16-way cable to the header socket on the main board. As noted before, the red stripe in the cable should line up with the pin 1 end of both header sockets.

You can now fit the main board into the case but before doing so, remove the two integral plastic mounting pillars at the front of the case. These pillars would otherwise foul the underside of the PC board. Fit the PC board into the base of the case and secure it with the two self-tapping screws, at the rear of the board.

The wiring from the switches to the PC board can be seen in Fig.3. Complete the wiring to the rear panel, as shown in Fig.3.

So far then, we have completed the DC version of the Light Show.

Testing

You can initially test the board without the halogen lamps connected as the front panel channel LEDs will mimic them. Set the BEAT switch to OSCILLATOR, the DISPLAY switch to UNMODULATED, the PATTERN switch to CHASER and the DIRECTION switch to FORWARD. Connect a 12V battery or DC power supply to the battery input terminals and turn the POWER switch on.

The power LED should light and

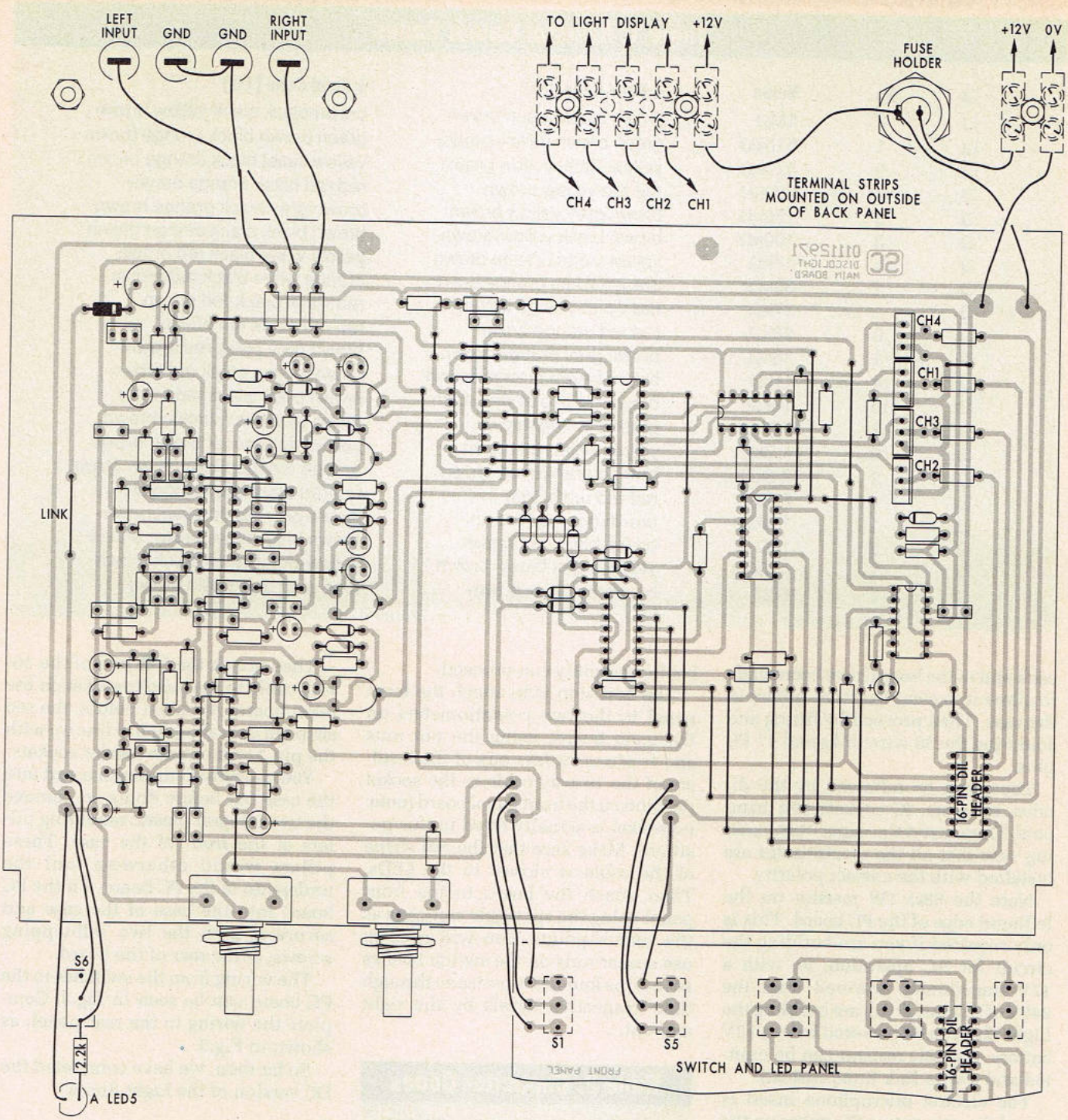


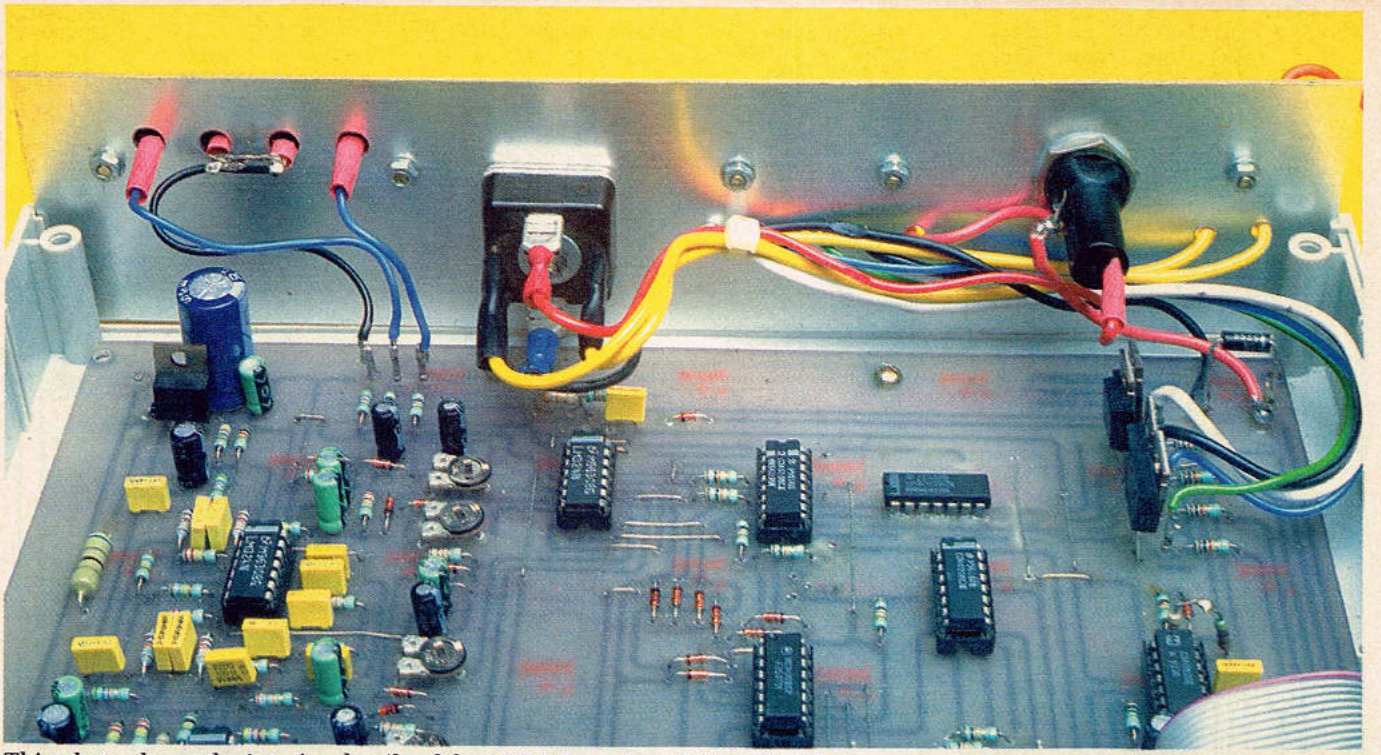
Fig.3: this diagram shows the wiring details for the 12V DC version of the Light Show. The terminal blocks shown dotted mount on the back of the rear panel.

the channel LEDs should light in sequence from left to right. If the DIRECTION switch is set to REVERSE these LEDs should chase in the opposite direction. The stepping speed should vary as the SPEED control is turned. In the AUTO position the sequence should reverse every minute or so.

Turn the PATTERN switch to STROBE and all four LEDs should pulse on and off, again varied by the SPEED control. Similarly, when ALTERNATE is selected, channels one and two should turn on and alternate with channels three and four.

So far so good. Now turn the BEAT switch to INPUT and set the INPUT switch to MICROPHONE. Turn the front panel LEVEL control to maximum, turn VR1 to VR4 fully clockwise, then tap the PC board gently near the microphone. Each time you tap, the pairs should alternate. If this is the case the only test left is the lamp modulation.

Turn the display switch to DISCO and sing or whistle into the microphone. If you lack these skills turn up the stereo and watch the intensity of the LEDs vary with the volume and frequency of the music.



This photo shows the interior details of the 12V AC version of the Light Show. The main difference is the addition of the bridge rectifier on the metal rear panel of the case and the 39V 5W zener diode across the 12V input terminals on the main PC board.

Finally, you should connect the four 20W or 50W halogen lamps and check that all functions are correct.

AC operation

The unit as described so far has been designed to operate from a 12V DC supply or car battery. If you want to operate from 12V AC, it needs a few mods to allow it to run from a suitable transformer.

Essentially, the modifications required are the fitting of a bridge rectifier to the rear panel which then acts as a heatsink, the addition of a 39V 5W zener diode across the supply following the 10A fuse and a 68Ω 1W resistor in series with the 3-terminal regulator. The modified power supply circuit is shown in Fig.4.

If you are using 20W halogen lamps, a suitable transformer for the AC version is the 12V 63VA halogen lamp transformer available from Jaycar Electronics (Cat MP-3050). The beauty of this transformer is that it is completely shrouded in a plastic case and is supplied with a two-core mains flex and plug. Hence, it can be mounted outside the chassis and will not present a safety hazard.

By the way, you could also use a large 12V battery charger if you have one on hand. Its rating should be 6A or more, if you are using 20W lamps. If you are going to use 50W lamps, you would need a much larger charger, rated at 15A or more.

Alternatively, you need a 12V transformer with a rating of 160VA or more. This will need to be installed in a suitable case.

The relevant wiring details for the AC version of the Light Show are shown in Fig.5. The 39V 5W zener diode is wired directly across the DC input pins.

Once you have wired up the AC version of the circuit, apply power and check that all of the above tests are OK. Then check its operation with the halogen lamps. If you are using 50W halogen lamps, you will find that the rear panel of the Light Show will become quite warm, due to the heat dissipation in the bridge rectifier.

AC/DC operation

If you have built the AC version of

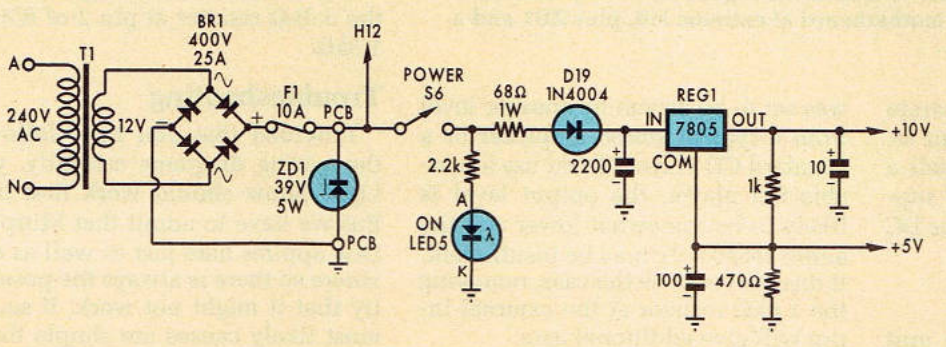


Fig.4: the power supply for the AC version incorporates a 12V AC transformer, a bridge rectifier and a 39V 5W zener diode. The zener diode damps spike voltages from the transformer which are generated by the switching action of the Mosfets.

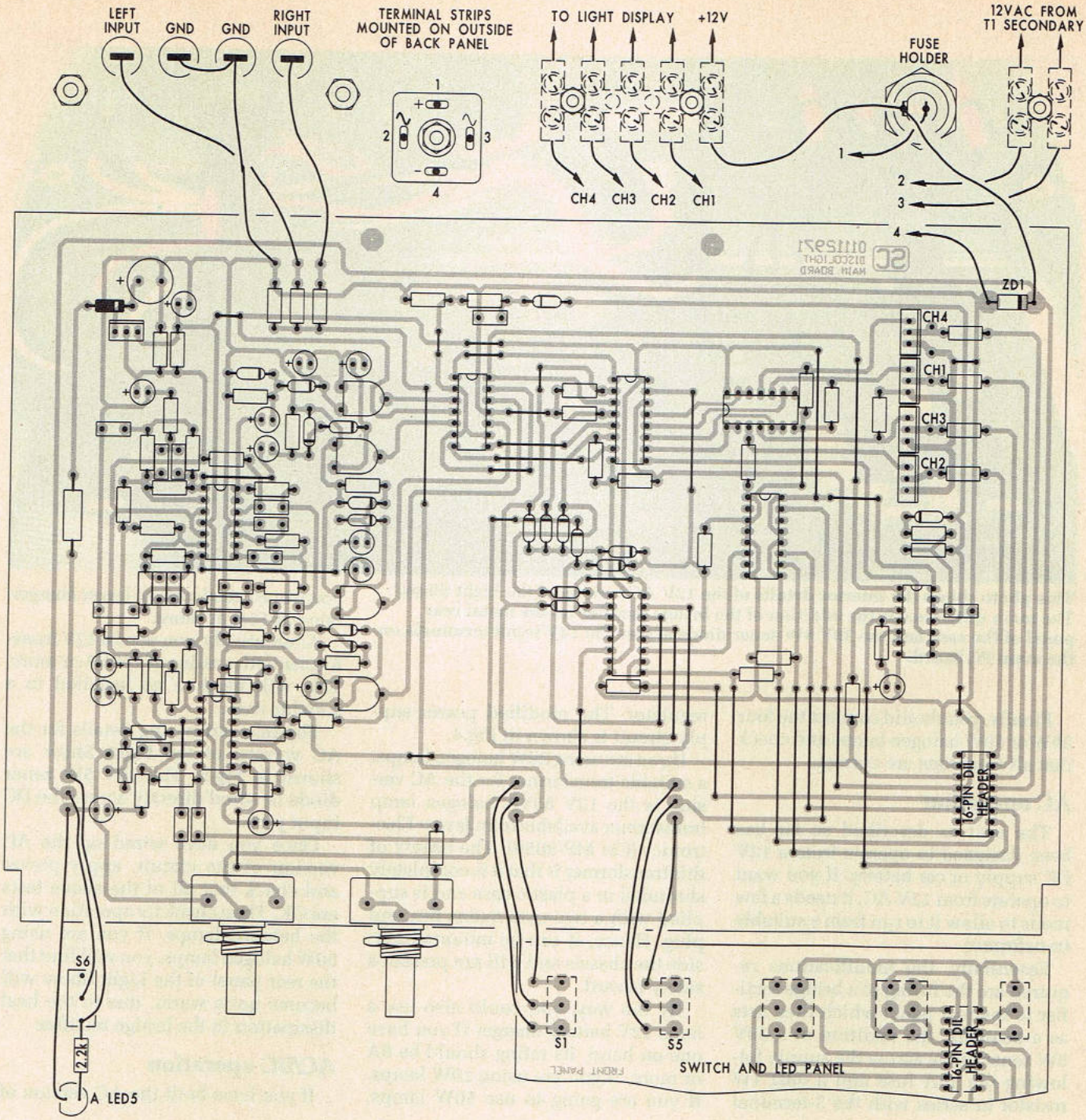


Fig.5: wiring details for the 12V AC version of the Light Show. Note that this version has a 68Ω resistor on the motherboard at extreme left, plus ZD1 and a few extra parts on the rear panel.

the circuit, it is still feasible to operate it from a 12V battery if you want to. However, you will need to install a switch to short out the 68Ω 1W supply resistor when operating in the DC condition.

More audio gain

The input sensitivity of the unit was set to be driven by speaker level from a typical stereo amplifier or a standard CD player. If you use a portable CD player, the output level is likely to be somewhat lower and the audio sensitivity may be insufficient. If this proves to be the case, removing the 1.8kΩ resistor at the external input will give additional gain.

If you need still more gain, reduce the 3.3kΩ resistor at pin 2 of IC1a to 1.5kΩ.

Troubleshooting

Provided that you have followed the wiring diagrams carefully, your Light Show should work first time. But we have to admit that Murphy's Law applies here just as well as anywhere so there is always the possibility that it might not work. If so, the most likely causes are simple things

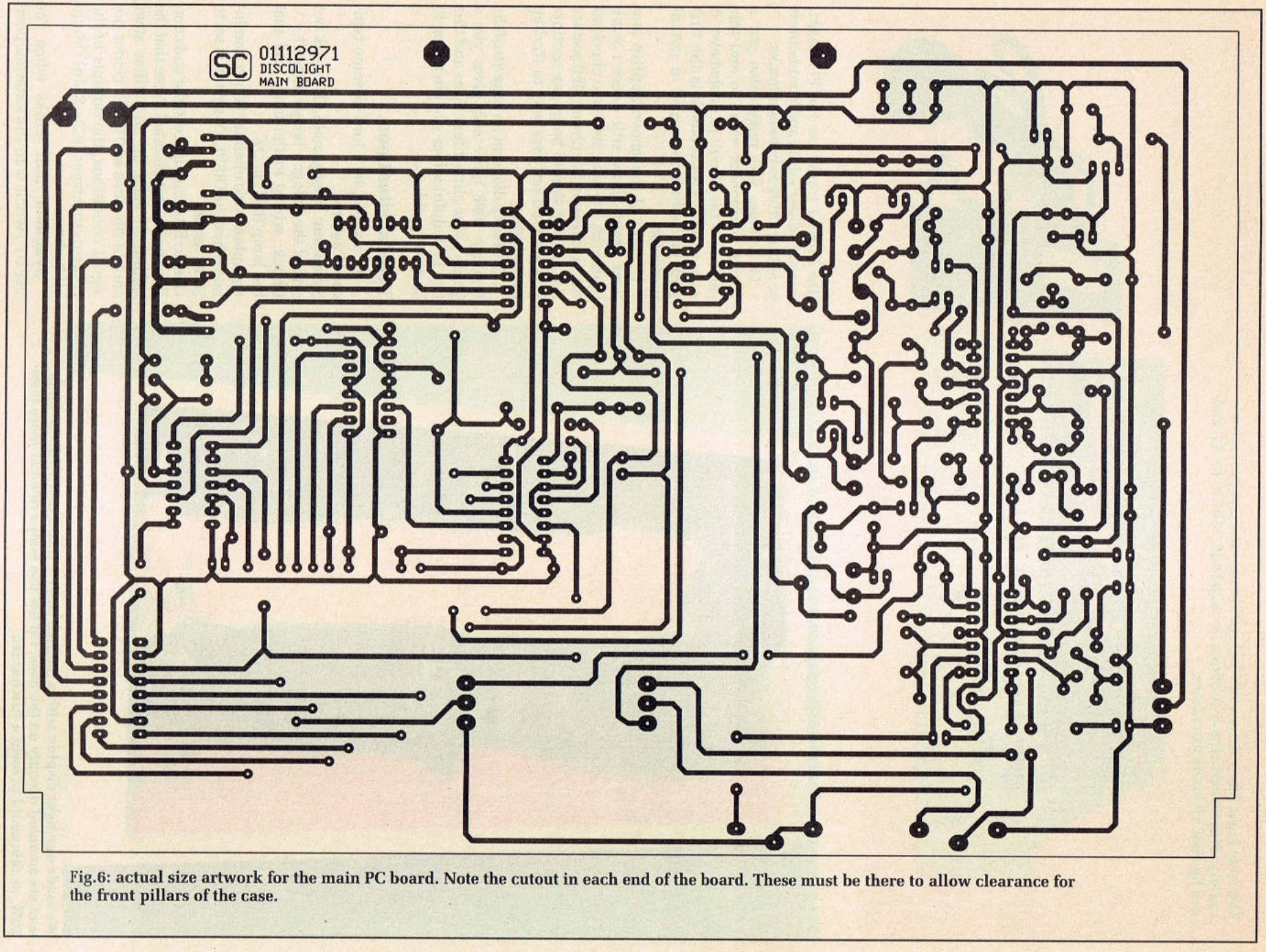
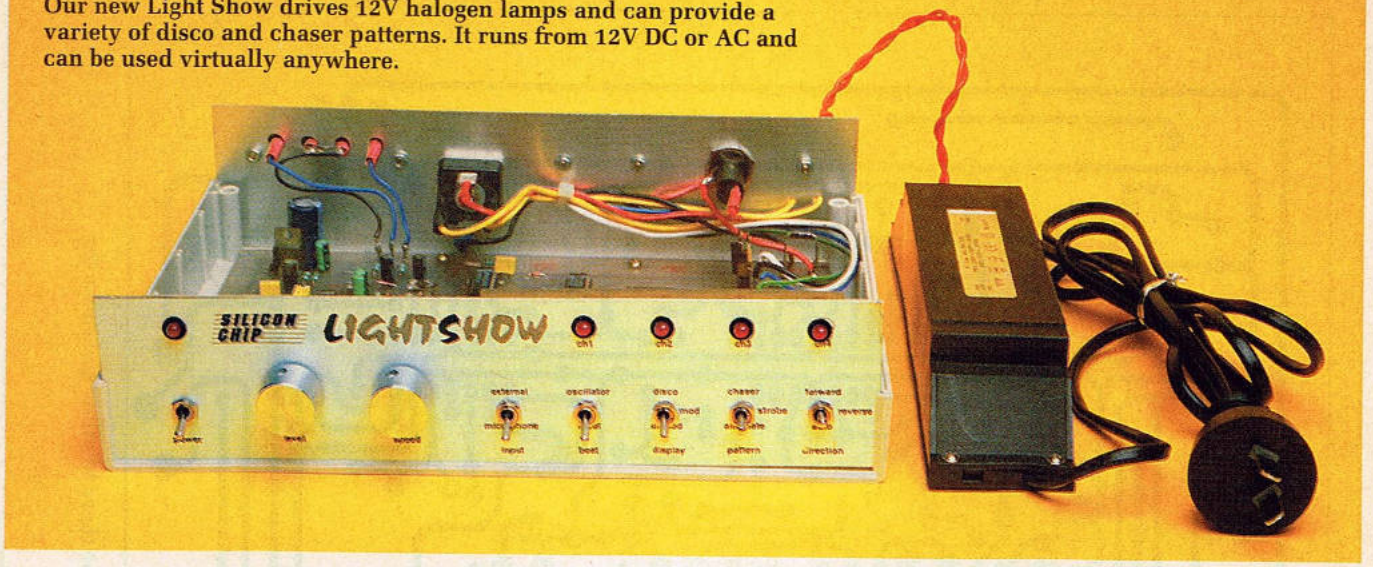


Fig.6: actual size artwork for the main PC board. Note the cutout in each end of the board. These must be there to allow clearance for the front pillars of the case.

Our new Light Show drives 12V halogen lamps and can provide a variety of disco and chaser patterns. It runs from 12V DC or AC and can be used virtually anywhere.



We made our light display with a painted timber frame and with the lamp sockets mounted directly on the base. Do not use lamps rated at more than 20W, as this could present a fire hazard.

like broken tracks on the PC board, missed solder joints and connections or solder bridges between tracks.

Of course, you might also put a wrong component value in and this can cause the circuit to misbehave. A very careful visual check is the first step in finding the cause of circuit problems.

If none of the above applies and your Light Show still doesn't work (dammit), the next step is to check all the voltages on the circuit. If these are not as they should be in any section, you are well on your way to finding the solution.

The block diagram on page 20 of the January 1998 issue also gives you a guide to the circuit functions and this can be helpful when you are trying to sort out problems.

Typical situations

As a guide, let's look at some typical situations:

Symptom: front panel LEDs work but one of the halogen lamps doesn't.

Check: wiring to the lamp and that the lamp itself is OK.

Symptom: one channel fails to modulate when the DISPLAY switch is set to DISC mode.

Check: filter circuit, rectifier and comparator for that channel. Note that the output of each op amp filter stage should be close to 0V DC. Under no-signal conditions, the outputs of the comparator stages (IC3a-IC3d) should all be low.

Symptom: unit works when the INPUT switch is in the External posi-

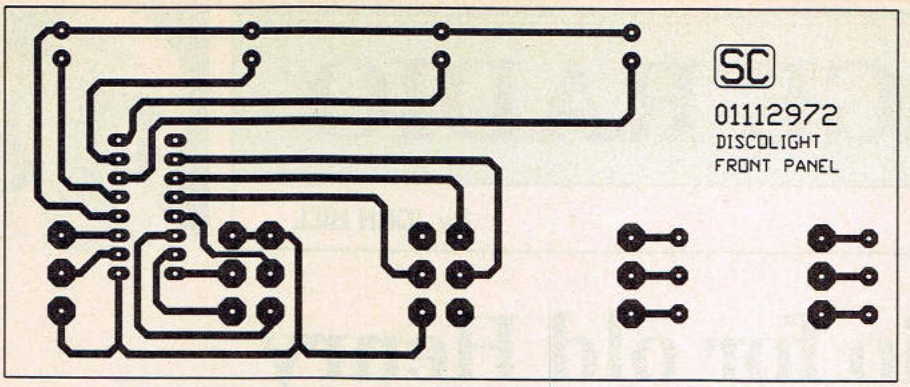


Fig.7: actual size artwork for the front panel PC board. Fig.8 at right shows the actual size artwork for the front panel.

tion but not in the Microphone position.

Check: the electret microphone circuitry associated with op amp IC1b. There should be about 6V DC across the electret.

Symptom: unit works only when the DISPLAY switch is set to the UNMOD position and the BEAT switch is set to Oscillator.

Check: wiring to INPUT switch S1, level control VR5 and the circuitry associated with op amp IC1a.

Symptom: lights do not chase or strobe when BEAT switch is set to Oscillator.

Check: circuit associated with oscillator IC1c. If you set the SPEED control to a low setting, you can check the oscillator operation with an analog multimeter set to measure 10VDC; ie, the pointer will swing back and forth at the frequency of oscillation.

You can also check with your multimeter to see that pins 6 & 11 of IC6 are also oscillating at the same rate. If not, check around IC6 and the wiring to the BEAT switch.

Symptom: the light pattern fails to automatically reverse after every minute or so, when the DIRECTION switch is set to AUTO.

Check: the wiring to the DIRECTION switch and the circuitry associated with IC4b. You can check with your analog multimeter to see that the output of IC4b is switching high and low at about one-minute intervals as the 100µF capacitor charges and discharges.

Symptom: lamps stay on in DISCO and MOD modes.

Check: the ramp voltage from IC4d does not stay low all the time. If so, check the operation of IC4d. The voltage at the output of IC4d, pin 11, should be about +2.3V. Ideally, the waveforms around IC3 should be checked with an oscilloscope to see that they match those in Fig.3 on page 21 of the January 1998 issue.

Well that's a fairly comprehensive list of possible faults. The trick is to isolate the fault to a particular part of the circuit and then critically examine that circuit section.

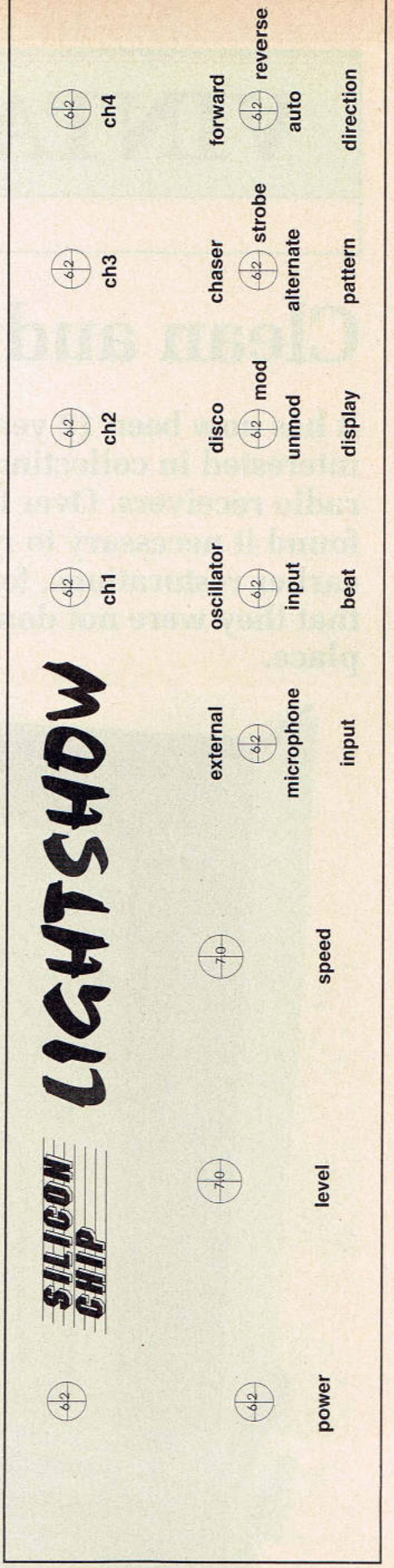
Light display housing

You will probably have your own ideas on how you want to build the light display but we'll still tell you how we made ours. Our display was made of scrap timber with a white Perspex front to diffuse the light. The frame measures 650 x 360 x 60mm. The four lamp holders were equally spaced and screwed to but held off the base with 5mm spacers. This prevents the wires from being jammed under the sockets.

A five connector strip was screwed to the back panel and one wire from each lamp was connected as the common to one terminal. The other four wires were connected, one to each remaining terminal. A five wire cable was plaited and connected to the terminal strip on the rear of the Light Show.

Four sheets of coloured cellophane were purchased from a newsagent. These were cut to 600mm, rolled and sticky taped into rough 40mm tubes to form coloured diffusers for the lamps. You can see the general arrangement from the photos.

Note that this arrangement is only suitable for 20W lamps (or lower). Do not use higher rated lamps if you intend building a similar lightbox to the one described here as the heat generated by them could easily cause the cellophane to catch fire. SC



VINTAGE RADIO

By JOHN HILL

Clean audio for old Henry

It has now been 12 years since I first became interested in collecting and restoring vintage radio receivers. Over that period, I have found it necessary to rework some of my earlier restorations, for the simple reason that they were not done correctly in the first place.

Henry is an early 1930s 7-valve superhet receiver of rather large proportions and is typical of the era. The challenge was to cure his audio distortion problems, which have been present since restoration many years ago.

Experience is not something that is acquired overnight. As one slowly advances in the art of valve radio repairs, there is a gradual realisation that some past restorations may not be as good as they could have been.

This was the case with old "Henry", a massive 7-valve console receiver of early 1930s vintage. Henry was so named because of his masculine appearance. With square corners, chunky proportions and shear bulk, Henry looks quite imposing and takes up plenty of space.

Henry is one of those numerous receivers that bear no manufacturer's name. These sets were made by well-known companies for various retail outlets which often (but not always) put their own trading name on them.

In Henry's case, the chassis could have been built by almost anyone and has no recognisable parentage. However, it certainly looks impressive, being built from large early 1930s components.

While the original restoration was broadly successful, there was slight audio distortion. Although unnoticed at the time, I have become increasingly sensitive to vintage radio receivers with less than perfect audio.

Many cases of audio distortion in old receivers are due to the anode bend detection method that was in common use during the early 1930s. However, in Henry's case, diodes in the 2A6 first audio valve handle the

detection and AGC functions. Therefore, any distortion must be due to causes other than the detection circuit.

So, like several of my early restorations, Henry required a reworking session.

Common problems

When this old receiver was originally restored, I found that there were three common vintage radio problems in need of attention - leaky paper capacitors, dead electrolytics and an open circuit output transformer.

The replacement transformer was selected mainly for its size (so that it would fit the existing mounting holes) rather than for its impedance specifications. But unknown to me at the time, the correct output transformer for this particular receiver has quite different specifications from most.

Henry has an unusual output stage which consists of two type 59 output pentodes in parallel, rather than push-pull. The two valves are wired grid to grid, plate to plate, etc. This arrangement provides twice the output power but is not as good as push-pull which has a number of advantages, including lower distortion.

A parallel output stage requires an output transformer with half the primary impedance of that used for a single output valve. In the case of parallel 59s, an output transformer with a 3kΩ primary is required but that is not what was installed when the set was restored. The transformer used would have been more in keeping with a battery receiver, as it had a 10kΩ primary.

So a bad impedance mismatch needed to be corrected for a start.

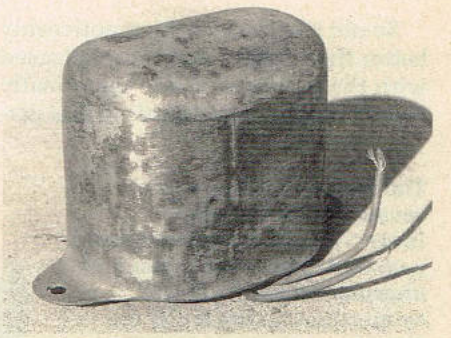
On top of that, one of 59s had an open heater. Readers unfamiliar with this output pentode may be surprised to learn that the valve has two heaters and will still work reasonably well when one is open. However, as there was a distortion problem to correct, a replacement valve was required.

Next was the problem of resistance values. The set used a particular brand of resistor that is notorious for going high, so it was not surprising that some were up to 100% out of tolerance. All the cathode bias resistors were wirewound types and the bias voltages were OK.

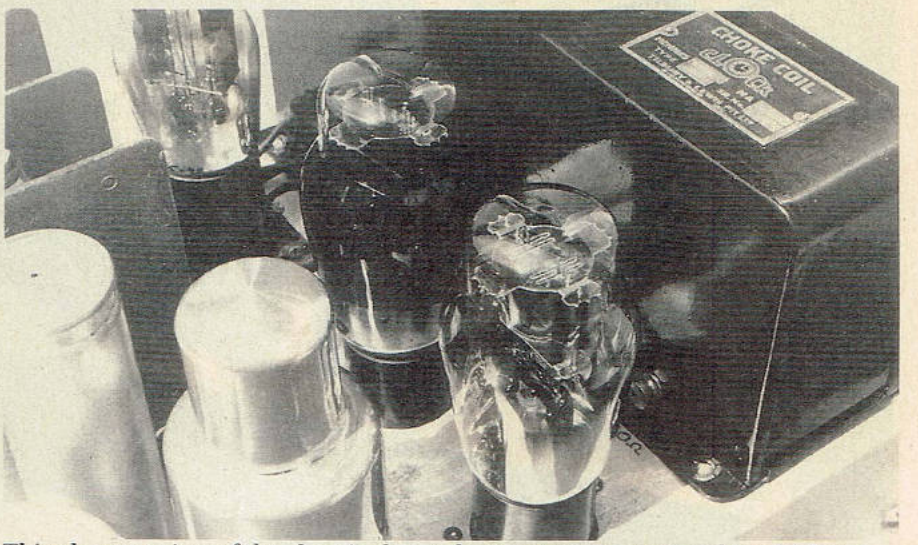
It was obvious that the partly defunct valve, the out-of-tolerance resistors and the output transformer would all have to be replaced. The replacement transformer was a 2.5kΩ "Isocore" type in a pressed steel can. While it looks a few years too modern for the set's age, it was the only transformer that came near the required 3kΩ primary. Being an Isocore type, with floating, "hot" laminations, it should be relatively troublefree.

The modifications had the desired effect and the sound from the old receiver was greatly improved. It is quite amazing how well some ancient loudspeakers perform. While they may not be equal to modern equipment, they are OK with the limited range of frequencies covered by AM radio.

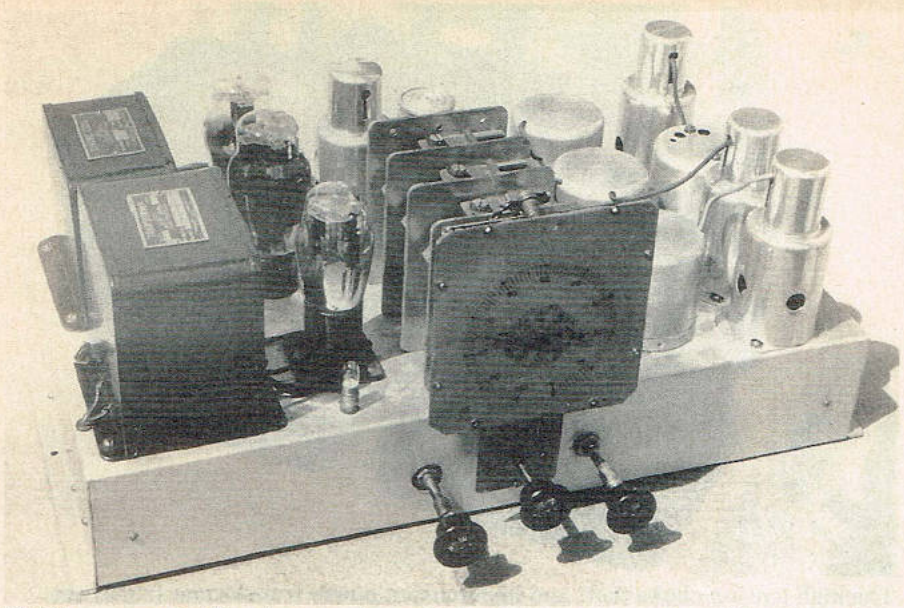
The high tension choke (left) and high tension power transformer (right) are mounted on the top of the chassis.



A 2.5kΩ "Isocore" output transformer was used to replace the earlier 10kΩ unit. This was necessary because the primary impedance required for parallel connected output valves is half that of a single stage.



This close-up view of the chassis shows the two 59 output pentodes which are wired in parallel. The old 59 was in production for only a short time and was superseded by the 2A5.



Old Henry was built using very large 1930s-style components and boasts no less than seven valves, including two 59 output pentodes wired in parallel.

So old Henry is working noticeably better than before and I was pleased with the outcome. While there really wasn't much to do regarding this particular repair, it does demonstrate how attention to details can make a difference.

Hernry's attributes

As Henry is an unusual receiver, I will finish off this month's column by describing some of his more interesting attributes.

Perhaps the most striking aspect about the chassis is its size and the choice of components used. In many ways, it appears to be over-engineered, the power transformers being one such example. There are two power transformers, one mounted above the chassis, the other below.

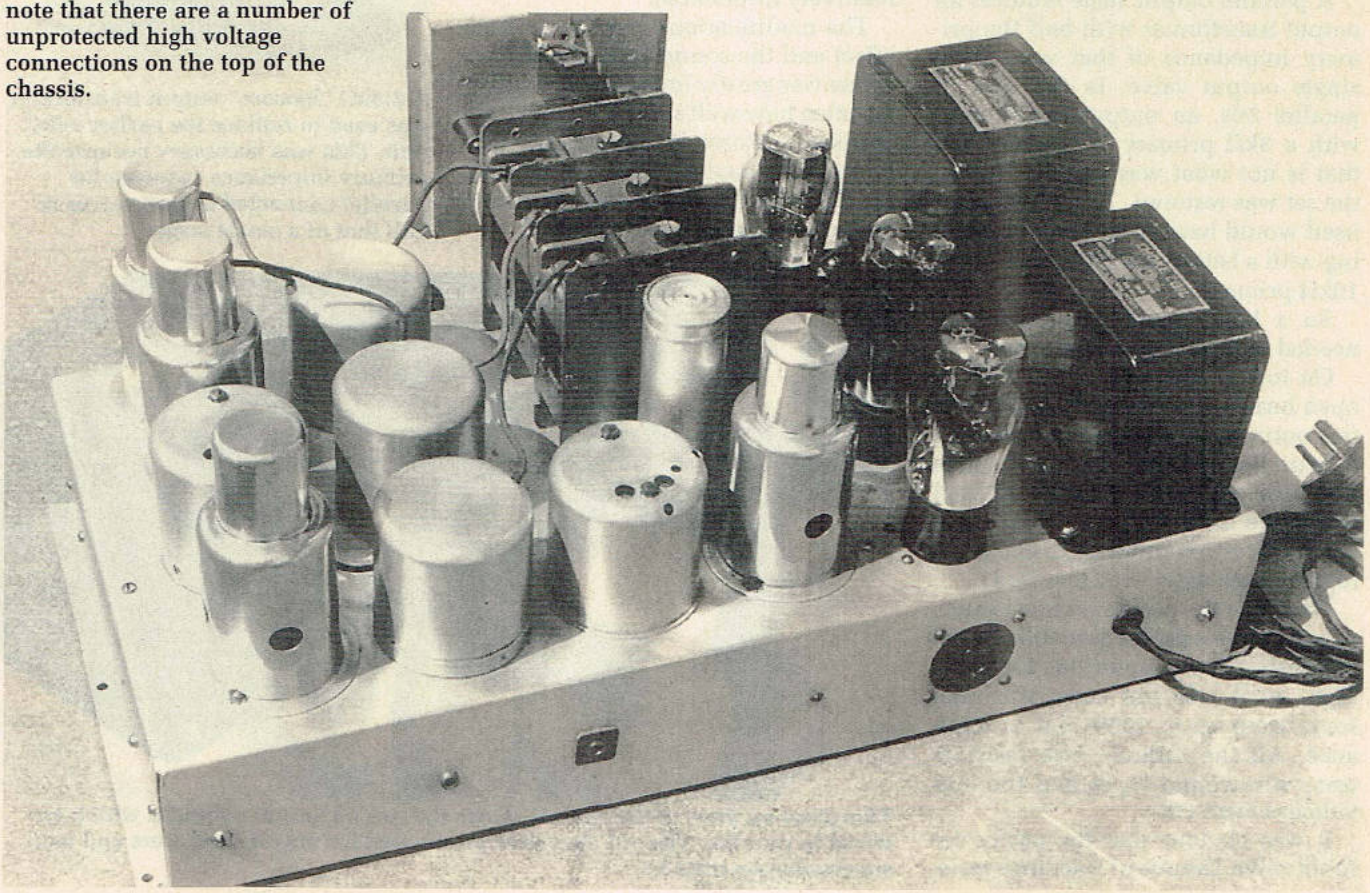
The high tension transformer is on top. It has two secondary windings: (1) a centre-tapped high voltage winding for the type 80 rectifier plates; and (2) a low voltage winding for the rectifier filaments.

A separate filament transformer is mounted underneath and supplies the remaining six valves. It delivers 2.5V and is rated at many amps. As the valve heaters collectively draw 8A, this transformer is quite large and of robust construction.

There is also a huge 30H, 85mA high tension choke mounted above the chassis next to the HT power transformer. These two units weigh quite a few kilograms and concentrate a lot of weight at one end of the chassis.

Both power transformers and the high tension choke operate at barely

The receiver is impressive because of its size alone. Inexperienced collectors should note that there are a number of unprotected high voltage connections on the top of the chassis.



warm temperatures even after several hours operation. Even then, the temperature increase is mostly due to the close proximity of the rectifier and output valves.

The front end valve line-up is: 58 RF amplifier, 57 autodyne oscillator/mixer and 58 IF amplifier. The gain of the two 58s is controlled by AGC. There is no AGC applied to the frequency converter as the autodyne circuit was unsuitable for AGC. The IF is 175kHz.

The 59 pentode

Mention has already been made regarding the 59's twin heaters and cathodes. The old 59 has other peculiarities that are also worth mentioning.

The 59 has a large 7-pin base which is marginally bigger than the standard 7-pin base of other valves such as the 6A7 and 6B7. As a result, 59s will not fit some valve tester sockets without the aid of an adaptor.

Another oddity of this valve is that its suppressor grid has its own base pin connection (hence the 7-pin base). Other pentodes have six pins, with the suppressor internally connected to the cathode.

Some servicemen of yesteryear do not speak very highly of the old 59 valve, claiming that it was weakly constructed, troublesome and inclined to go gassy. Personally, I've encountered none of these problems.

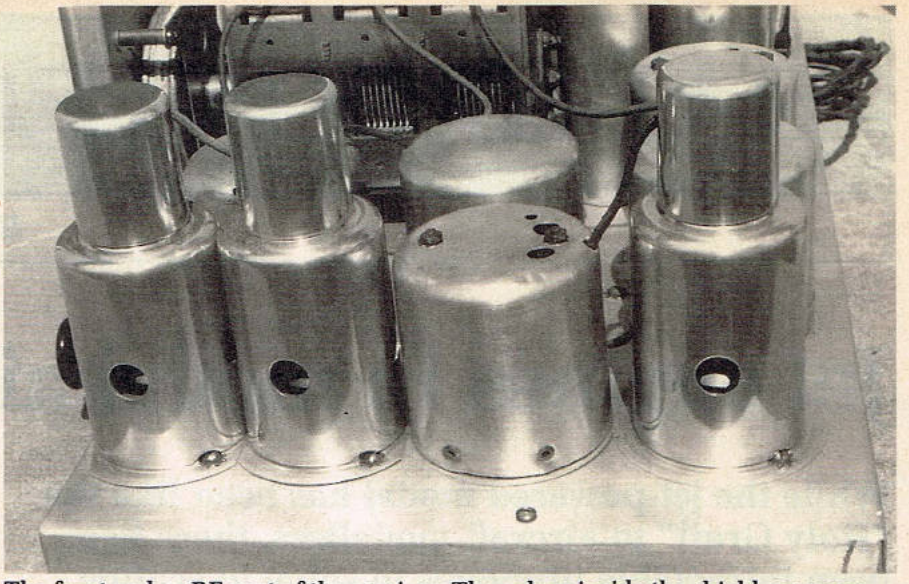
(A staff member who was familiar with these valves recalls that they were prone to what was virtually instant destruction in the event that the plate voltage was lost – as with an open speaker transformer which caused a red hot screen. No-one ever reached the switch in time!)

The 59 was in production for only a short time and was replaced by the 2A5. The 2.5V series of valves was, in fact, short lived, being superseded by 6.3V types at about the time Henry was built.

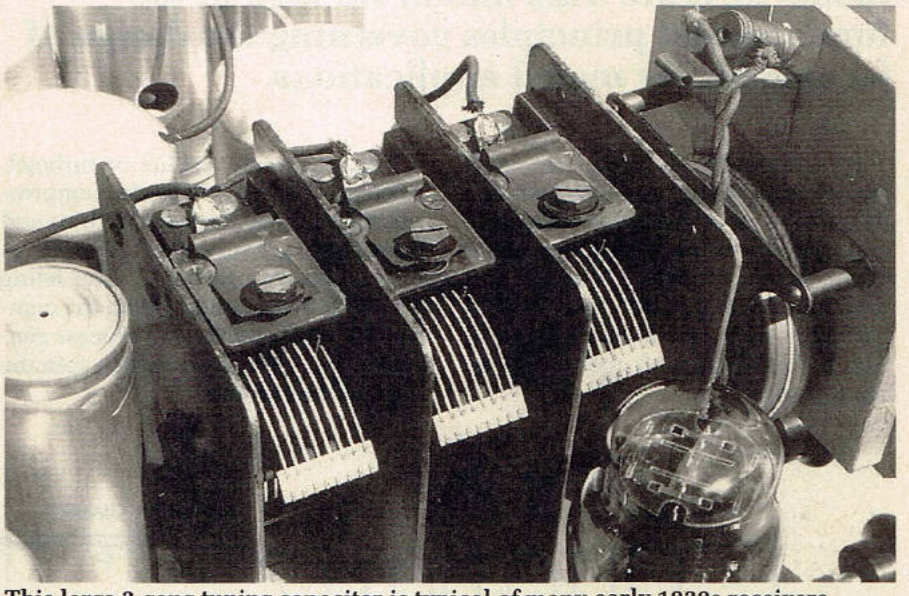
Dangerous voltages

Perhaps the worst aspect of Henry is the unprotected – and potentially lethal – high voltage connections above the chassis, where one would least expect to find them. Inexperienced collectors/repairers should take note of the following.

Most manufacturers of the era endeavoured to keep high voltage nasties confined underneath the chassis.



The front end or RF part of the receiver. The valves inside the shield cans are: 58 RF amplifier, 57 autodyne mixer and 58 IF amplifier.



This large 3-gang tuning capacitor is typical of many early 1930s receivers. Miniaturisation had not been thought of then.

However, this was not always the case, as an examination of Henry clearly reveals.

The rectifier socket is mounted above the chassis. Its bare external connections are within easy reach of any careless fingers that may venture close enough to touch those high plate voltages.

Similar bare connections (in the form of terminals) are to be found on the high tension choke. These connections are easily reached (even when the chassis is in its cabinet) and they have a DC potential in excess of 300V.

Finally, another dangerous and potentially fatal nasty is on the high tension power transformer. A bare unused 240V primary connection protrudes from the transformer cover. It seemed prudent to tape over this hazard. Mains voltages, by reason of their low source impedance are by far the most dangerous.

So that's about all there is to report on old Henry. He has always been one of my favourites and now he's better than ever.

In fact, Henry is one of those nice old receivers that makes collecting vintage radios such an enjoyable hobby. **SC**

RADIO CONTROL

BY BOB YOUNG

Jet engines in model aircraft; Pt.2

While the jet-powered model has been like the "Holy Grail" to aircraft modellers, there have been intractable problems to solve in scaling down the jet engine to make it fit into typical model aircraft. This month we look at the fundamental principles governing the design of jet engines for model applications.

Jet propulsion of a body such as an aircraft is quite simply explained. The propulsive force is developed in reaction to the ejection of a high-speed jet of gas. In other words, it is *action* and *reaction*. The action is to squirt a lot of gas out at high velocity and the reaction is that the aircraft zooms off into the distance.

The jet-driven turbine or turbojet, consists of four basic parts: compressor, combustion chambers, turbine and propelling nozzles. Fuel is burnt in the combustion chamber, after being mixed with air coming from the compressor. The combustion process generates expanding gases which spin the rotor of the turbine.

The shaft of the turbine is connected directly to the axis of the compressor so the turbine drives the compressor. After passing through the turbine, the gas is exhausted to the atmosphere at high speed through a nozzle.

In the propeller-driven turbine or turboprop, the turbine not only drives the compressor but also drives a normal propeller.

A ramjet engine relies on its own forward motion to compress the air that enters it. The Turboprop and ramjet have no model equivalents and thus will not feature in this series.

Fig.1 shows the basic layout of a typical jet engine.

The development of jet engines for use in models has proven to be a very difficult task, largely because of "scale effect". Briefly, there are two separate

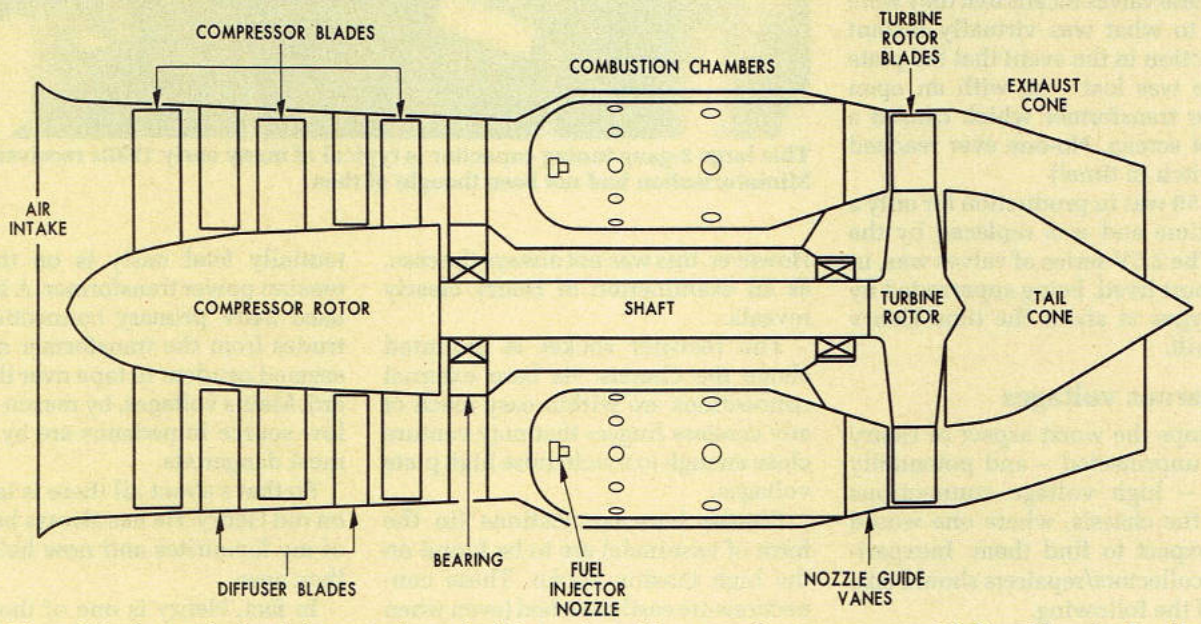
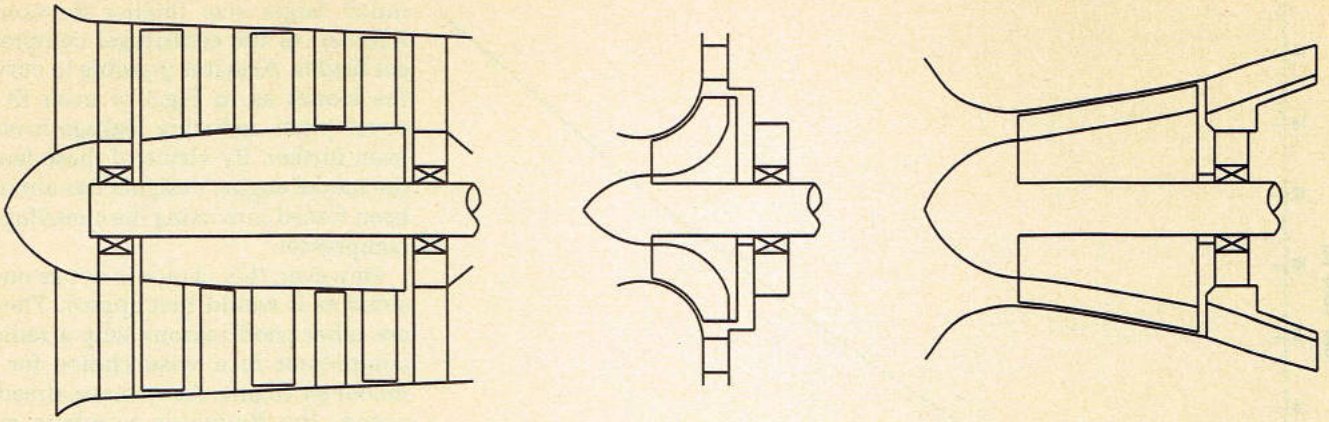


Fig.1: this shows the basic layout of a typical jet engine. Air enters the compressor at left and is mixed with fuel which is burnt in the combustion chamber. The expanding waste gases then drive the turbine before being exhausted. The turbine is directly connected to the compressor.



(a) AXIAL COMPRESSOR (b) RADIAL COMPRESSOR (c) DIAGONAL COMPRESSOR

Fig.2: these are the three basic forms of jet engine compressor. Because of its lesser sensitivity to scale effect, the radial compressor is most suited for use in jet engines for models.

problems relating to scale effect. First, we have the problem of machining tolerances. For example, as the compressor and turbine are reduced in size, the gap between the rotor and its housing becomes more significant when expressed in terms of a percentage of air leaking past the compressor/turbine relative to the volume flowing through the compressor/turbine. Compounding this are the problems of metallurgy and expansion due to heat.

Second, we have the problem of the loss of aerodynamic efficiency as the compressor/turbine blades are reduced in size. The engine designer would refer to the latter problem as "difficulties with Reynolds numbers". In plain English, this simply means that as the size of a wing, propeller or turbine blade moves closer to the size of air molecules, the laws of aerodynamics start to break down.

Now of all of the modern propulsion units, the jet engine is perhaps the most reliant upon aerodynamic theory for its successful operation. We have all heard that in theory the bumblebee should not be able to fly. Among the reasons that aerodynamicists would give for this, Reynolds number is high on the list.

Without going too deeply into the complex mathematics of Reynolds numbers with their strange units (slugs), it is sufficient to state for this series of articles that the Reynolds number is given by the formula:
R = Density x Velocity x Size/Viscosity.

The higher the Reynolds number, the greater the efficiency.

Built by Chris Patterson of Brisbane, this superb 1/7th scale F18 carries the colours of 75 squadron of Williamstown, NSW. It is powered by two OS91 motors driving a Ramtec fan unit. The model has a length of 2.49 metres and a wingspan of 1.82 metres.

Reynolds numbers for full size flight vary from about 2,000,000 for small slow speed aircraft up to about 20,000,000 for large high speed aircraft.

Combine this with the fact that lift increases with the square of the velocity and the large high speed aircraft becomes very efficient indeed. This is largely the reason that a modern jet fighter can carry much the same load as a World War II bomber

Thus it is quite clear that as size decreases and the velocity falls to model speeds, the Reynolds number falls away rapidly and the efficiency of any aerodynamic device tumbles. By the time we arrive at turbine blades of a size suitable for model engines, efficiency is very low indeed.

As a result, the design of successful turbines for models has centred around components which are the least sensitive to scale effect. This has lead to the almost universal adoption of the centrifugal compressor for model aircraft jet engines.

Fig.2 shows the three basic forms of jet engine compressor in order of common full size usage. Fig.2(a) shows the axial compressor, Fig.2(b) shows

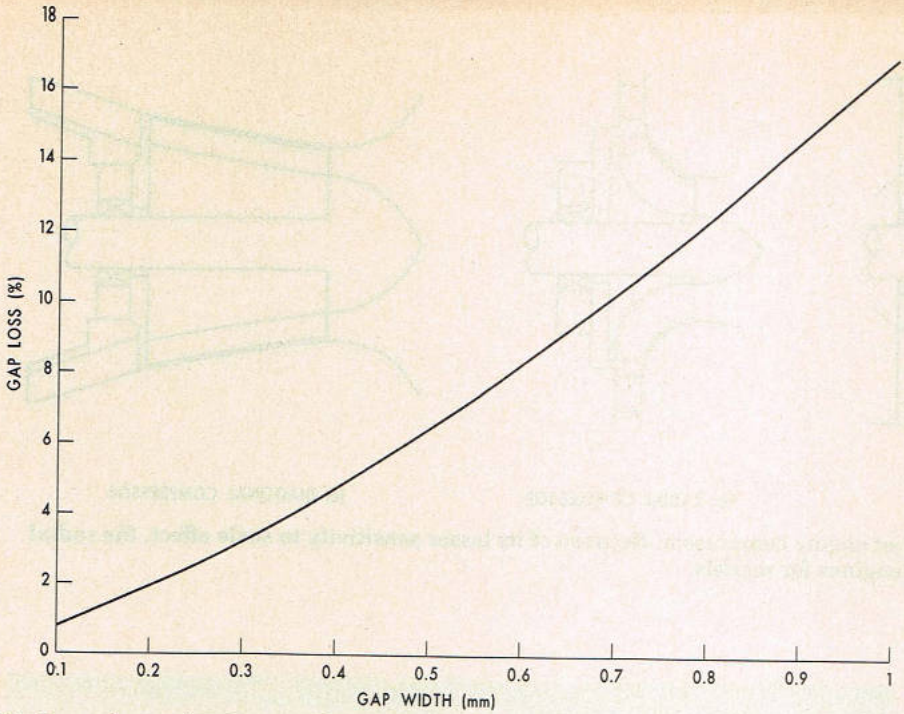


Fig.3: gap losses increase as the gap between a compressor and its housing are increased. These effects are magnified in jet engines for model use.

the centrifugal (or radial) compressor and Fig.2(c) shows the diagonal compressor.

Early full size jet engines tended to favour the centrifugal compressor for a variety of reasons but the resulting engine is shorter and greater in diameter than the axial flow type and thus not the ideal shape to fit into a slender fuselage or engine nacelle.

However, for model size engines the centrifugal (radial) compressor is the ideal choice. Once again we must consider scale effect in the choice of the compressor. Referring back to Fig 2, note the gap between the tips of the compressor blades and the housing in the axial and diagonal compressors. No matter how tight the machining tolerances, there will always be some leakage between the blade tip and the housing.

Fig.3 shows gap losses at various gap widths.

Now look at the situation for the centrifugal compressor. By the very nature of the design all of the air is thrown off the tip into the collector (diffuser) ring. True, there will be some leakage past the compressor face but that is more than made up for by the much larger size (higher Reynolds number) of the centrifugal compressor blades. Also it is possible to curve the blades as in Fig.5 or even fit a cover plate, reducing leakage losses even further. By virtue of these facts the model engine designer has almost been forced into using the centrifugal compressor.

However, this choice is not as one-sided as it would first appear. There are other good reasons why a radial compressor is a wise choice for a model jet engine. As we have already noted, the Reynolds numbers are higher and the tip losses are less. In addition, they are easier to construct, are much more robust and therefore more reliable in operation.

Constructing a model size axial compressor with its rows of tiny compressor and diffuser blades would be a very difficult and tedious task. Then there is the problem of anchoring the blades solidly enough to withstand speeds in excess of 100,000 rpm and possible ingestion of foreign matter.

What must be borne in mind at all times is the very high rotation speeds encountered in these engines. Shaft speeds in excess of 100,000 rpm are routine in model size turbines. When combined with very high temperatures there is a real danger of compressor or turbine failure and this must be guarded against at all times. Fig.4 shows the typical operating conditions for a model jet engine.

There is also a more subtle consideration to the radial compressor and we will deal with this shortly. The downside of the radial compressor is

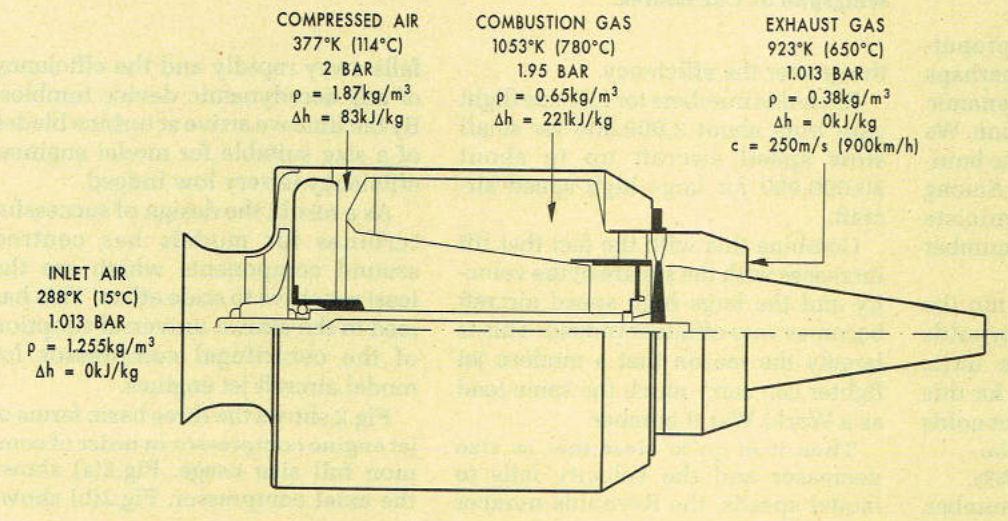


Fig.4: typical operating conditions for a model jet engine. Note also that the engine may be rotating at up 100,000 rpm!

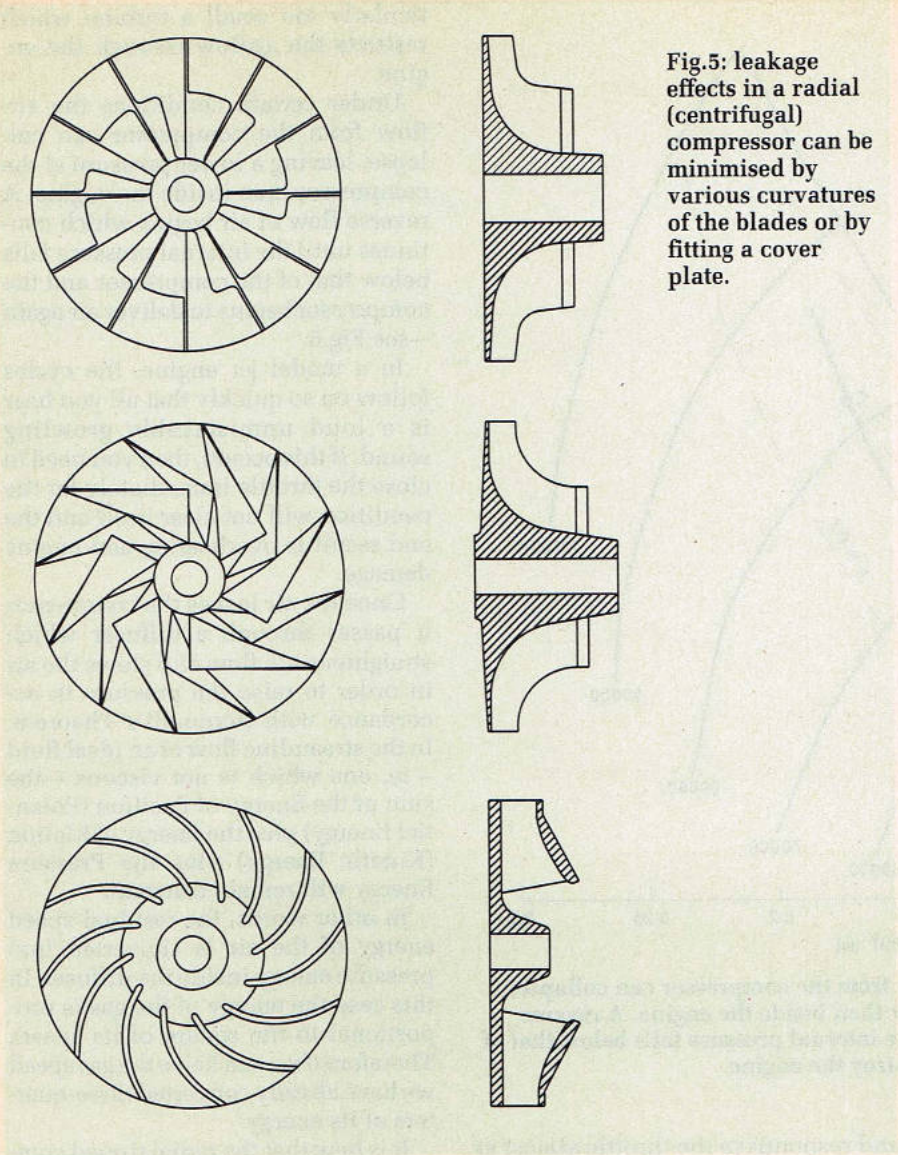


Fig.5: leakage effects in a radial (centrifugal) compressor can be minimised by various curvatures of the blades or by fitting a cover plate.

the more rotund appearance of the completed motor. It is nowhere near as slender as the axial flow engine. Notwithstanding this, the final size of a successful centrifugal compressor type of engine is well within the limits available in a reasonable size modern jet fighter model.

Automotive turbo chargers

All that aside, the most important factor in the choice of centrifugal compressors in model engines is the fact that turbo superchargers for cars use radial compressors which are an ideal size for model work.

Now automotive turbo superchargers are very highly developed devices. Just what drove the turbo designers to radial compressors is not known but the preceding considerations probably played a large part in the development of these devices.

Whatever the reasons, the automotive turbocharger provided a perfect jumping off point for early experimenters and radial automotive turbocompressors found their way into many an experimental model jet engine. As supplied, turbocharger compressors are accurately dynamically balanced, a very important point. They achieve efficiencies of between 70 and 80%, depending upon their size; the larger the compressor, the higher the efficiency.

The radial compressor can be built in many configurations, all with widely differing characteristics. Firstly, there is the matter of cover plate or no cover plate, the former being known as an "enclosed wheel" compressor.

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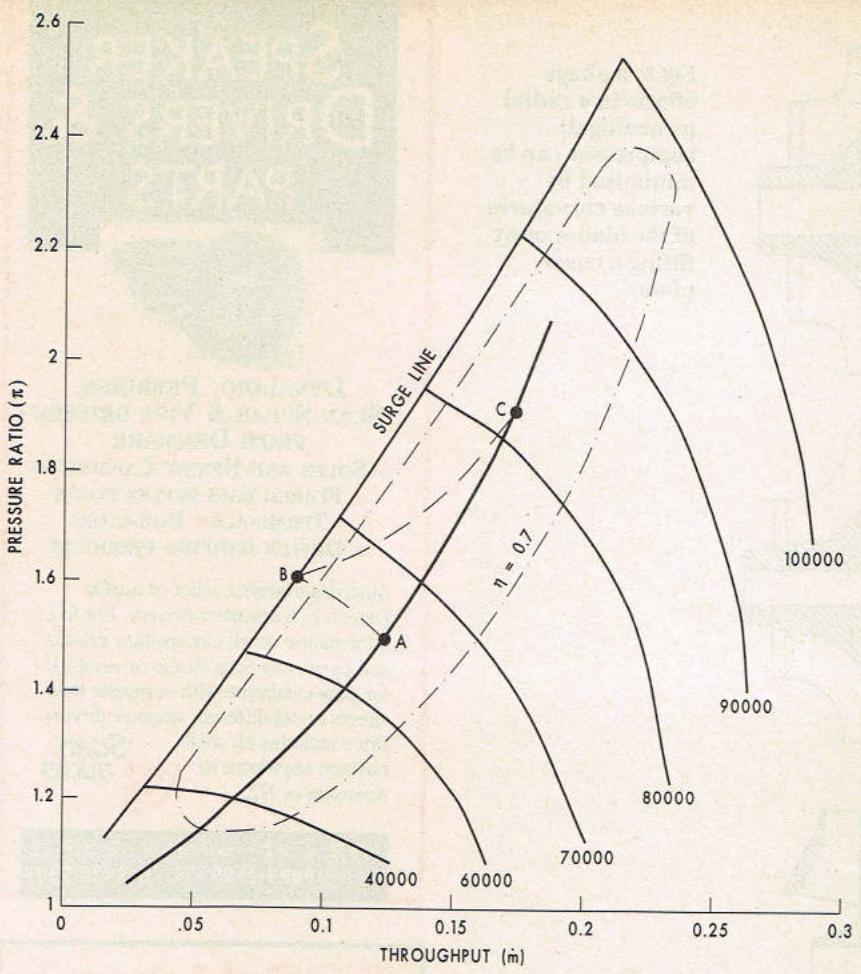

Fig.6: under certain conditions the airflow from the compressor can collapse, leaving a lower pressure at the compressor than inside the engine. A reverse flow of air begins which continues until the internal pressure falls below that of the compressor. This cycling effect can destroy the engine.

Secondly, there is the matter of blade curvature. Fig.5 shows radial compressors with various configurations. Fig.5(a) shows radial tipped blades, Fig.5(b) shows slightly retro-curved blades and Fig.5(c) shows an enclosed wheel with highly retro-curved blades.

Throttle response

Experiments have shown that the compressor with retro curved blades is more efficient overall than the straight blade compressor. However, more subtle effects of blade curvature are to be found in the very important feature of throttle response. In aircraft work, it is imperative that throttle response be as close to instantaneous as possible. The Me262 was very vulnerable during landing and take-off due to poor throttle response and allied airmen exploited this weakness to the full. Kurt Schreckling's FD 3 model engine uses a retro angle of 45 degrees and responds to the throttle almost as quickly as a well-adjusted piston engine.

I could write an entire chapter on throttle response, throughput and blade curvature as it really is at the very heart of the jet engine and it is here that we encounter the dreaded surge line. The "surge limit" of a compressor refers to the tendency to supply the working medium cyclically instead of constantly. This may sound a little innocuous but to the full size aviator it is viewed with considerable alarm, since the usual result is damage to the engine which may progress to the very serious.

In model size engines the effects are not as dramatic but the compressor can still be damaged if the surge limit is exceeded. To simplify an exceedingly difficult subject, compressor surge is often the result of mismatched components at the design stage, particularly too small a turbine which restricts the airflow through the engine.

Under certain conditions the airflow from the compressor can collapse, leaving a lower pressure at the compressor than inside the engine. A reverse flow of air begins which continues until the internal pressure falls below that of the compressor and the compressor begins to deliver air again – see Fig.6.

In a model jet engine, the cycles follow on so quickly that all you hear is a loud unmistakable growling sound. If this occurs, then you need to close the throttle immediately for the condition will not clear itself and the end result is overheating and engine damage.

Once the air leaves the compressor it passes through a diffuser which straightens the flow and slows the air in order to raise the pressure in accordance with Bernoulli's Theorem. In the streamline flow of an ideal fluid – ie, one which is not viscous – the sum of the Energy of Position (Potential Energy) plus the Energy of Motion (Kinetic Energy) plus the Pressure Energy will remain constant.

In other words, the residual speed energy of the air is converted into pressure energy inside the diffuser. In this case the energy of the gas is proportional to the square of its speed. Therefore if we can halve the gas speed we have already converted three-quarters of its energy.

It is here that the radial tipped compressor blades vary from the retro curved blades. The radial tipped blades use the diffuser to raise the pressure whereas the retro-curved compressor begins the process inside the compressor itself. Thus the losses are higher in the radial compressor.

Once the air passes through the diffuser it enters the combustion chamber and then the hard part begins. Burning the fuel/air mix evenly and efficiently, avoiding overly long flames which result in localised hot spots on the turbine, and preventing raw fuel pooling in the engine or running out onto the tarmac are all very difficult tricks to master.

A model jet belching a metre-long flame may look spectacular but it ain't gonna last long!

Next month, we'll talk about taming the combustion chamber and turbine. **SC**

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Newnes Guide to Satellite TV

Installation, Reception & Repair. By Derek J. Stephenson. First published 1991, reprinted 1994 (3rd edition).

This is a practical guide on the installation and servicing of satellite television equipment. The coverage of the subject is extensive, without excessive theory or mathematics. 371 pages, in hard cover at $55.95.

Guide to TV & Video Technology

By Eugene Trundle. First published 1988. Second edition 1996.

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This is a practical handbook from one of the world's most prolific audio designers, with many of his designs having been published in English technical magazines over the years. A great many practical circuits are featured – a must for anyone interested in audio design. 336 pages, in paperback at $55.00.

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Produced by the Sony Service Centre (Europe). 3rd edition, published 1995.

Prepared by Sony's technical staff, this is the best book on compact disc technology that we have ever come across. It covers digital audio in depth, including PCM adapters, the Video8 PCM format and R-DAT. If you want to understand digital audio, you need this reference book. 305 pages, in paperback at $59.00.

Power Electronics Handbook

Components, Circuits & Applications, by F. F. Mazda. Published 1990.

Previously a neglected field, power electronics has come into its own, particularly in the areas of traction and electric vehicles. F. F. Mazda is an acknowledged authority on the subject and he writes mainly on the many uses of thyristors & Triacs in single and three phase circuits. 417 pages, in soft cover at $59.95.

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Radio Frequency Transistors

Principles & Practical Applications. By Norm Dye & Helge Granberg. Published 1993.

This book strips away the mysteries of RF circuit design. Written by two Motorola engineers, it looks at RF transistor fundamentals before moving on to specific design examples; eg, amplifiers, oscillators and pulsed power systems. Also included are chapters on filtering, impedance matching & CAD. 235 pages, in hard cover at $95.00.

Electronics Engineer's Reference Book

Edited by F. F. Mazda. First published 1989. 6th edition.

This just has to be the best reference book available for electronics engineers. Provides expert coverage of all aspects of electronics in five parts: techniques, physical phenomena, material & components, electronic design, and applications. The sixth edition has been expanded to include chapters on surface mount technology, hardware & software design, semi-custom electronics & data communications. 63 chapters, soft cover at $125.00.

Audio Electronics

By John Linsley Hood. Published 1995.

This book is for anyone involved in designing, adapting and using analog and digital audio equipment. Covers tape recording, tuners & radio receivers, preamplifiers, voltage amplifiers, power amplifiers, the compact disc & digital audio, test & measurement, loudspeaker crossover systems and power supplies. 351 pages, in soft cover at $55.00.

Understanding Telephone Electronics

By Stephen J. Bigelow. Third edition published 1997 by Butterworth-Heinemann.

This is a very useful text for anyone wanting to become familiar with the basics of telephone technology. The 10 chapters explore telephone fundamentals, speech signal processing, telephone line interfacing, tone and pulse generation, ringers, digital transmission techniques (modems & fax machines) and much more. Ideal for students. 367 pages, in soft cover at $49.95 (please note price rise).

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CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Electronic circuit breaker

This circuit is suitable for switching resistive loads running from a 12-24V DC supply. The circuit will operate to disconnect the load at peak currents in excess of 40A at 25°C. The trip current will be reduced to about 20A at 125°C.

When the circuit has tripped, the load can be removed to reset the unit or the overload can be removed and S1 pressed again.

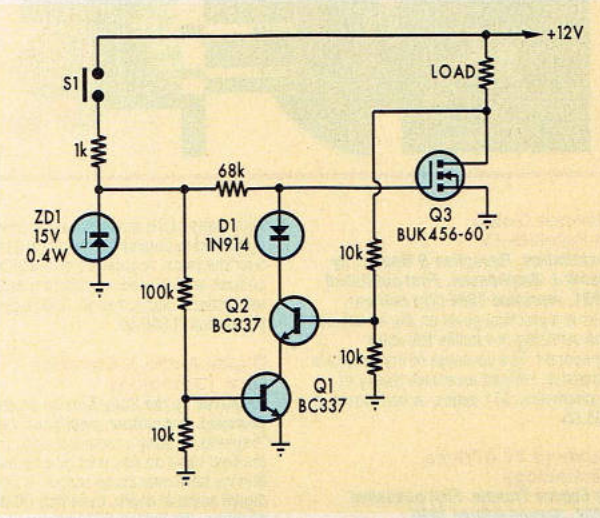
The circuit works by detecting a rising drain source voltage across the BUK456-GO.

At switch-on, no gate voltage is applied to the Mosfet Q3 and so no current passes to the load. When switch S1 is closed, gate current is applied to Q3 via a 68kΩ resistor. At the same time, transistor Q1 is supplied with base current via a 100kΩ resistor, while Q2 is held off by the 10kΩ resistor between its base and 0V.

If the load current rises, the drain voltage of Q3 will rise in proportion. Once the drain voltage rises above about 1.2V, Q2 begins to turn on, shunting the gate current away from Q3 via diode D3.

As shown, the unit is suitable for resistive loads. If the circuit is required to switch inductive loads, a suitably rated freewheel diode should be connected (ie, reverse biased) across the load.

If incandescent lamp loads with start-up surges of more than 40A are likely (eg, 60W halogen lamps), then a 0.1µF capacitor should be connected between base and emitter of Q1.



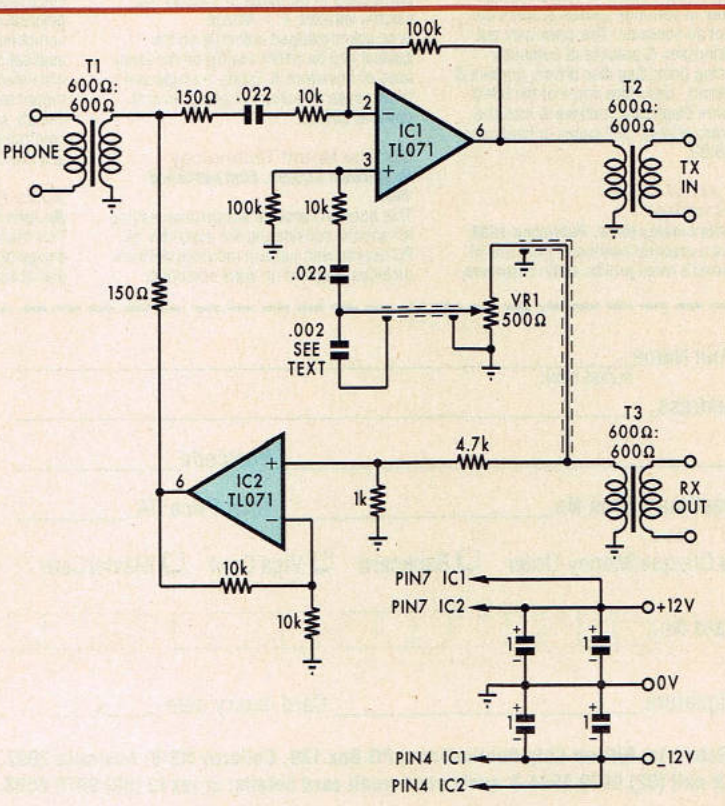
G. LaRooy,
Christchurch, NZ. ($30)

Simple op amp hybrid

This circuit has many practical uses where a telephone line needs to be interfaced with some type of audio equipment. The 600-600Ω transformers on the transmit and receive lines are only required if these lines are to work into balanced circuits. Where possible, the use of capacitors has been avoided as they introduce undesirable phase shifts. Any phase shift caused by the two .022µF capacitors is corrected by the .0022µF capacitor and the null pot VR1.

The value of the .0022µF capacitor may need to be altered, in conjunction with adjustment of the null pot, to completely eliminate any signal at the receive transformer from reaching the transmit transformer. Both op amps are TL071 types and wiring to the null pot should be with screened cable. The circuit is designed to run from a split supply of ±12V.

S. Williamson,
Hamilton, NZ. ($40)



Quasi-peak detector

A quasi-peak detector is commonly used for the measurement of noise pulses in electromagnetic emissions, for example, to check the EMC compliance of appliances. It differs from a true peak detector in that its response to noise pulses varies as a function of the pulse rate. This gives a weighted response which reflects the subjective effects of EMI which also vary with noise pulse rate.

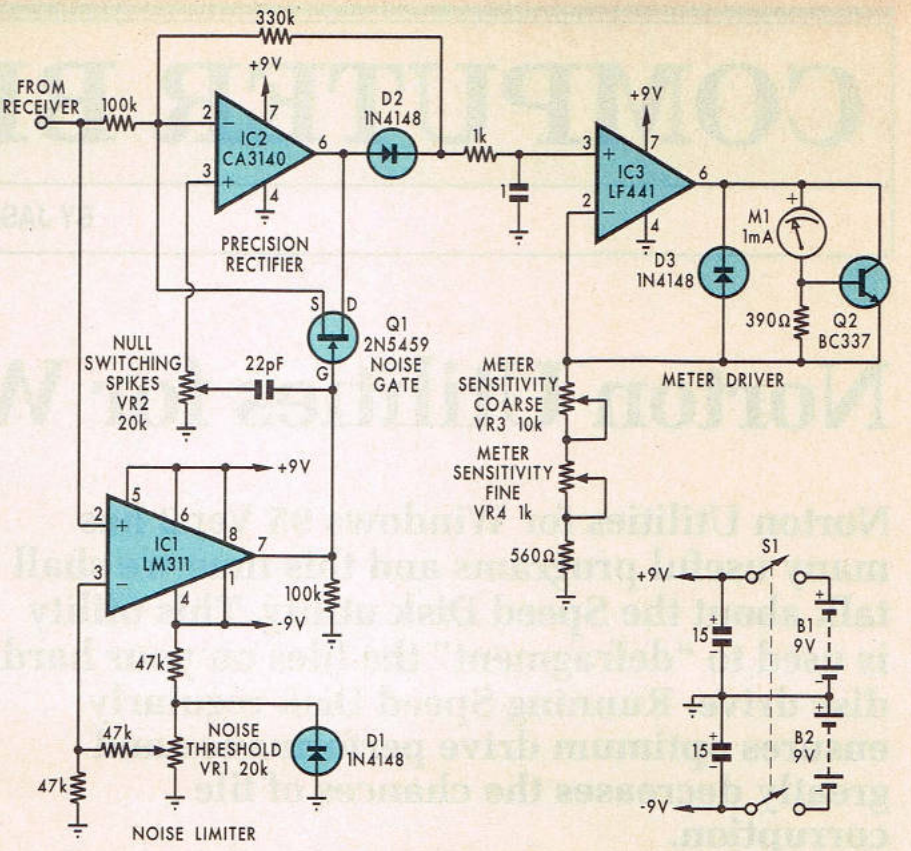
This circuit was designed to be connected to the output (envelope detector stage) on an RF receiver or a spectrum analyser. The detector was found to give close correlation with the calibration characteristics specified in AS/NZS 1052, which is the Australian/New Zealand standard applying to EMI measuring apparatus.

The features of this circuit include good linearity over a wide range (-30dB to +6dB relative to 0dB at centre scale), combined with high background noise immunity.

Noise pulses from the receiver are fed to precision rectifier IC2 which produces a positive output voltage in response to negative input pulses. This charges a 1uF capacitor via a 1kΩ resistor. The time constants of the 1µF capacitor and associated 1kΩ and 330kΩ resistors are critical to the calibration of the detector and may need to be adjusted depending upon the receiver final IF bandwidth. The values shown were chosen for an IF bandwidth of 15kHz at -6dB.

To prevent the background noise between pulses from creating measurement errors, comparator IC1 produces a high level output in the absence of input noise pulses. This turns on FET Q1 which, in turn, effectively shorts the output of IC2 to ground. When pulses exceeding a threshold level set by VR1 arrive at the input, IC1 generates negative gating pulses which turn off Q1, removing the effective short across the output of IC2.

VR2 is adjusted to cancel switching pulses induced by capacitive coupling from the gate of Q1 into IC2. An oscilloscope should be connected to the output of IC2 when making this adjustment.



Buffer amplifier IC3 is used to drive a 1mA meter which, ideally, has a logarithmic (dB) scale. Calibration consists of applying suitable calibrated noise pulses at various pulse rates (typically 1Hz to 1kHz) to the receiver and adjusting VR3 and VR4 for the desired output deflection on the meter. For compliance with the current standards, the characteristics of the calibration noise pulses are defined in AS/NZS 1052.

H. Nacinovich,
Gulgong, NSW. ($40)

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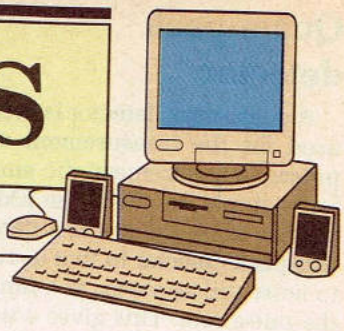
COMPUTER BITS

BY JASON COLE



Norton Utilities for Win95; Pt.2

Norton Utilities for Windows 95 Ver.2 has many useful programs and this time we shall talk about the Speed Disk utility. This utility is used to "defragment" the files on your hard disc drive. Running Speed Disk regularly ensures optimum drive performance and greatly decreases the chances of file corruption.

What is file "fragmentation"? Fragmentation occurs when files are split into smaller segments (or fragments) and written to scattered locations on the hard disc drive. This means that the drive has to work harder in order to open and save the affected files.

Fragmentation occurs as files are written to and subsequently deleted from the drive. The reason for this is that when you delete a file, you create a "hole" in the main block of data where the files resided. This means that any subsequent files that are saved can be written to the free space left by this hole. Now if the file is larger than the hole, then what ever is left over is written in the next available hole.

Adding to this, temporary swap files such as used in Windows 95 are continually changing size and being written and deleted. This is why there is always some fragmentation on the drive. A small amount of fragmentation doesn't cause any problems but if left unchecked, the speed and reliability of the drive will be reduced.

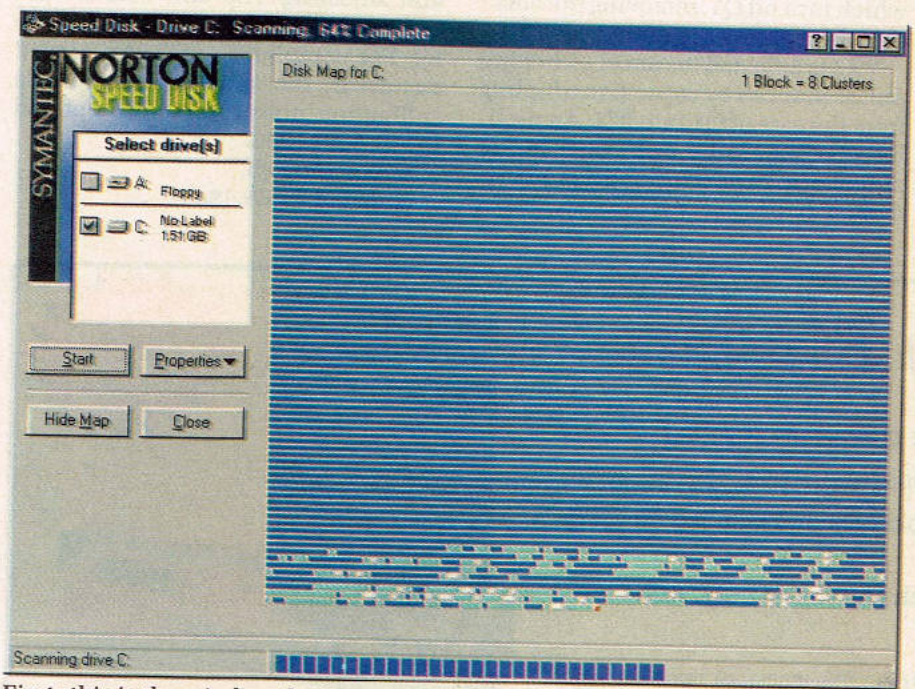


Fig.1: this is the window that appears when you first load Speed Disk. The program scans your hard disc drive first to see if there are any errors.

Speed Disk

Speed Disk is a powerful hard disc reorganisation tool. It works in a similar way to Symantec's Defrag, which is already installed on most computers with DOS. The main difference here is that Speed Disk is a lot more powerful.

Before running Speed Disk, it's important to note that you should always use Norton's Disk Doctor to correct any errors on the drive. If you don't check for errors before running Speed Disk, you run the risk of losing files.

When you load Speed Disk, the program scans the hard drive first – see Fig 1. This is just a quick check and is similar to Disk Doctor. If problems are detected, Speed Disk will inform you to run Disk Doctor to correct any errors. However, this does not happen often if you have already run Disk Doctor beforehand.

After the hard drive has been scanned, a new dialog box appears (Fig.2). This box tells you the percentage of fragmentation. In this case, 8% of the drive is fragmented. We can now start defragging the drive or quit.

Fig.2 (above): this dialog box shows the amount of file fragmentation and indicates which of three options is recommended.

Fig.3 (left): the Legend dialog box lets you change the colours on the disc map.

If we choose to go ahead, then there are three options:

(1). Full Optimisation: this reorganises the entire drive so that all files are at the beginning of the drive and in one piece.

(2). Unfragment Files Only: this collects any fragmented files and rewrites them so that they are not fragmented.

(3). Unfragment Free Space: this is similar to Unfragment Files Only, except that it works with the free space. This will leave fragmented files fragmented but will supply you with a section of the drive, generally at the end, which is clear of any files.

Finally, there is a check box at the bottom labelled Optimize Swap File". If you check this box, Speed Disk will move the Windows swap file to the end of the data. This minimises future file fragmentation and also speeds up the swap file by eliminating the need to search for it all over the drive.

If you now click Start, Speed Disk will start to organise the drive. This can take quite some time on older drives, large drives and extremely fragmented drives. However, if you choose Cancel, then you are taken back to the main screen (Fig.1). After a few moments, the display shows you some more detail about the drive, such as Swap File location, unmovable file locations and so on.

Clicking the Properties button and then clicking Legend from the resulting menu brings up the box shown in Fig.3. This box lets you change the colours on the disc map but most people will stick to the default settings.

You can view a fragmentation report of your data in the Properties menu (Fig.4) or you can click Properties, Options to bring up the dialog box shown in Fig.5. This is where the fun begins because you have three tabs to click and lots of options to choose from. These tabs are Optimization, Appearance and Advanced. We'll look at each option in turn.

(1) Optimization: this area gives you the same original options as shown in Fig.2, as well as two extra options. These extra options are Verify Writes and Wipe Free Space.

Verify Writes takes longer because it checks the data after writing it to see if it has been written correctly.

Wipe Free Space does just that – it wipes the free space after the data has been written. This makes it almost impossible to find any files that may have been deleted from the remaining area.

Next to the Full Optimisation section is an extra button called Customize. This section lets you place particular files and folders in certain sequences. You can set up the program to place folders or even files first. You can place particular folders which are rarely used or written to at the beginning of the drive and folders that are continually being written to at the end, for example.

Once you have chosen a particular setup and started the process, you can get yourself a nice cup of coffee as it will take a while the first time. This is because most files will have to be moved whether they are fragmented or not.

(2) Appearance: clicking the Appearance tab brings up the dialog box shown in Fig.7. This gives you a couple of options for the Disk Map. Here, you can have the data appear as Blocks or Bars. Click between them to see which one you like. You also have the option of playing music while the disc is defragging – just tick the Play Music box and select a WAV or MIDI file from the drop-down list.

Me? – I generally leave the room while the disc is defragging and come back later.

(3) Advanced: this area allows you to set up Background Operation (Fig.8). In this case, defragging will start after one minute of idle time and

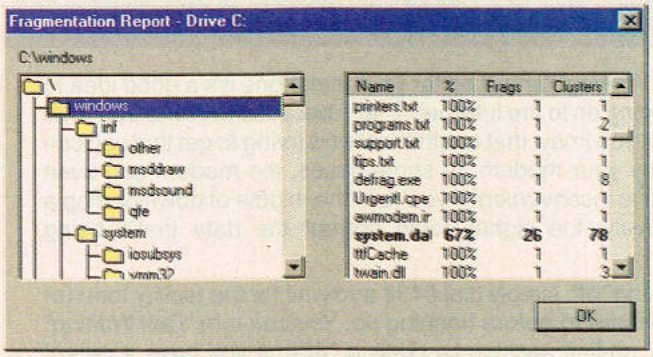


Fig.4: the Fragmentation Report dialog box shows the amount of fragmentation for each file on the hard drive.

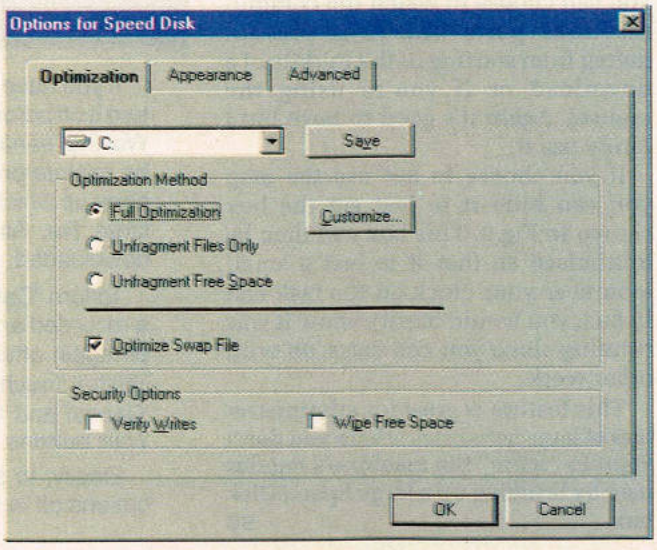


Fig.5 (right): this dialog box lets you choose the optimisation method (in this case, Full Optimization) and whether or not to optimise the swap file. There are also a couple of security options; ie, Verify Writes and Wipe Free Space.

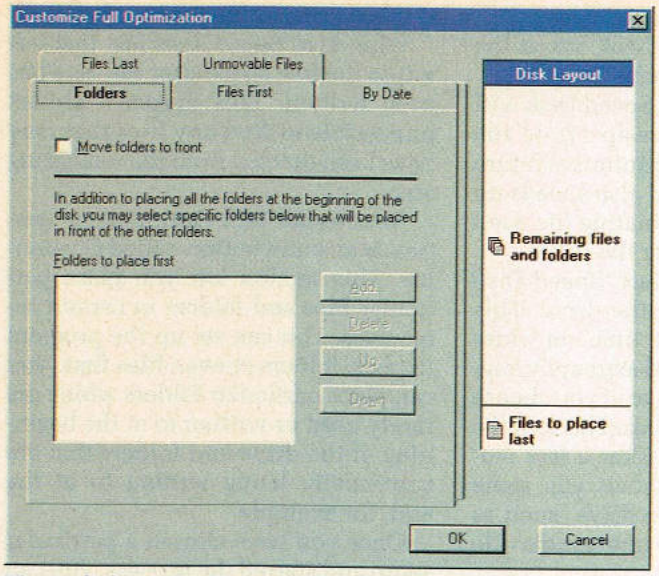


Fig.6: clicking the Cutomize button in Fig.5 brings up this dialog box which lets you place particular files and folders in certain sequences.

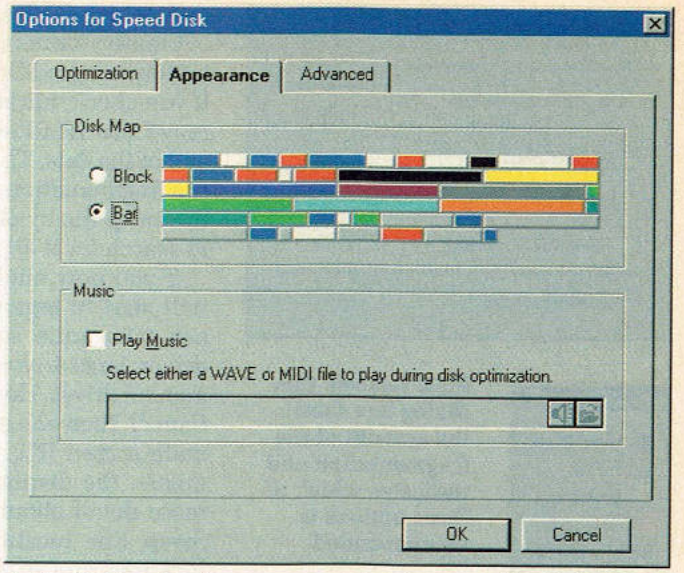
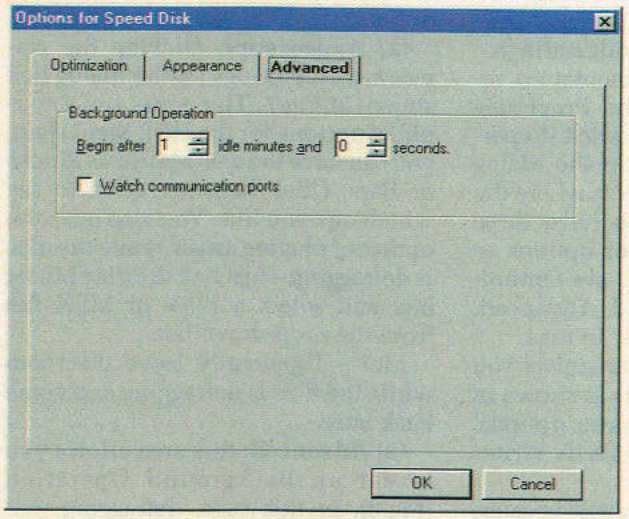


Fig.7: clicking the Appearance tab brings up this dialog box. Here, you can choose to have the data appear as blocks or as bars. You can also play music while the disc is defragging.



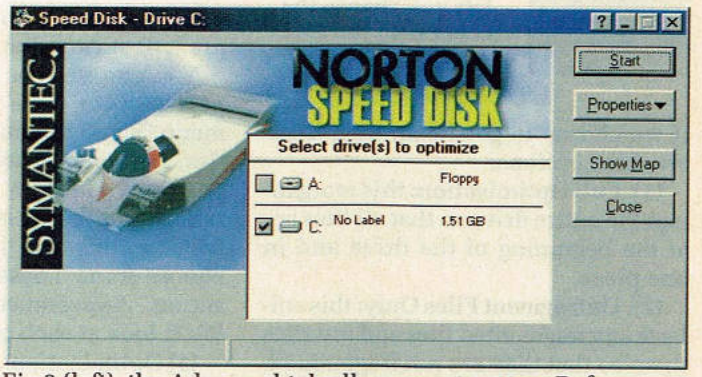


Fig.8 (left): the Advanced tab allows you to set up Defrag to run in the background. In this case, defragging will start after one minute of idle time. Fig.9 (above) shows the on-screen display if you choose to hide the disc map, or you can minimise this so that it appears as an icon in the tray on the task bar (near the clock

you can choose to watch the communications ports (this will prevent defrag from starting in the middle of a download or if you're using the mouse). Again it's good to have but I rarely use it.

If you choose to not use the map you can hide it to just get the box shown in Fig.9. This box can then be minimised so that it is just a small icon near your clock on the task bar. In fact, you would hardly know it was running since you can carry on with other work.

This feature is great for administrators of large networks, where you don't want to "scare" the machine's regular user by bringing up a large Speed Disk box. **SC**

Tip Of The Month

If you have "Call Waiting" turned on for your telephone it's a good idea to turn it off before logging on to the Internet. That's because the tone that "Call Waiting" sends to let you know that another caller is trying to get through can be misinterpreted by your modem. In some cases, the modem can even hang up which is quite inconvenient if you're in the middle of downloading a large file. Alternatively, the signal could corrupt the data that's being downloaded.

To turn "Call Waiting" off, simply dial #43# and wait for the facility tone (or a recorded announcement) before hanging up. You can turn "Call Waiting" on again after your on-line session by dialling *43#. If you have a recent Telstra Touchphone 400, you can turn "Call Waiting" off by pressing the 'Cancel' and 'Call Wait' buttons; or on again by pressing the 'Store' and 'Call Wait' buttons.

Finally, to speed up your web browsing, turn the graphics and sound options off in Internet Explorer and Netscape.

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Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097.

Colour TV pattern shift

I built the Colour TV Pattern Generator described in the June & July 1997 issues. It worked from switch on and it does everything it is supposed to do; well, almost.

The dot pattern comes up symmetrical in the screen – evenly spaced top/bottom and left/right of the screen. The checker board and grid cum circle are both displaced slightly to the right, say about two thirds of a grid square. Any suggestions or do I have a ROM programming problem? (R. G., Oyster Bay, NSW.

● The slight displacement of the pattern is due to a small timing discrepancy in the line sync signal. In most cases, the normal overscanning of the TV screen will mask out this small shift. It could be fixed in the programming of the EPROM but can be more easily corrected by adding an RC network to delay the line sync by 1.5µs. This involves adding a 4.7kΩ resistor between the D7 output of IC1 at pin 11 and the sync input of IC10 at pin 16. The pin 16 input of IC10 is bypassed to ground with a 270pF capacitor.

The resistor is best installed instead of the link on the PC board, above the three 330Ω resistors near IC10. Note that IC10 has an incorrect pin 1 labelling on the PC board. The position shown for pin 1 is actually pin 16. The capacitor can connect from pin 16 to pin 1 of IC10 on the underside of the PC board.

We have had a report of this RC time delay causing loss of colour. If this happens, you can try a smaller value of capacitance instead of 270pF. However, our approach would be to ignore the slight pattern shift – it's not worth correcting.

Mega power amplifier proposed

Firstly I would like to commend SILICON CHIP for producing the recent class A/B 500W power amplifier (August, September, October); it is "just what the doctor wanted". I personally favour bipolar output stage designs if you are seeking powerful deep bass. I also experienced similar problems with Mosfet output stage design amps producing a leaner bass and reduced power output due to thermal heat build up, etc.

I intend to purchase and build two 500W modules to drive a 4 x 15-inch active sub-bass system and another two 500W modules for 4 x 12-inch upper bass drivers and additional Mosfet amplifiers for mids and highs for my insane, fully-active home hifi system.

Before I purchase multiple numbers of the 500W amps, I would appreciate your help concerning some aspects of the design. If I understand your design correctly, it will not operate efficiently or effectively below a 4Ω speaker load. With two 15-inch woofers connected in parallel, I measure their total impedance at 3.6Ω (on an LCD meter). The impedance is probably lower at various frequencies. How may I solve the lower speaker impedance problem so your 500W amplifier will correctly and efficiently drive my woofers connected in parallel?

I intend to use a 2000VA (2kVA) toroidal transformer, additional power supply capacitors and surge limiters and additional 4 x NPN and 4 x PNP output stage transistors in each power amplifier. Will I have to change the value of the current sharing resistors incorporated in the output stage design? If so, what is the new value of the current sharing resistors in the output stage?

If I remove Q24 & Q25 and the associated 270Ω & 300Ω resistors from the circuit, will this eliminate your current limiting protection to enable me to drive correctly a lower speaker impedance than 4Ω?

Due to the enormous 350W RMS (8Ω) power handling capacity of each of my 15-inch drivers, to achieve more power I would like to increase the power supply rails of the 500W amplifier from 80V or 90V to 100V and

Intelligent transistor tester wanted

I am writing to suggest two kit ideas I think would be useful. The first idea is a transistor tester that will tell you whether the unknown transistor is PNP or NPN and also tell you which pin is which (Base, Collector and Emitter).

The second idea is for a dual power supply for op amps with variable output voltage for both rails (say ±1.5 to ±25V) and one total variable current limit (say 0-1A) for both rails. I feel that both these ideas will be of great benefit to hobbyists and professionals alike. (R. M., Attadale, WA).

● The concept of a transistor tester which can tell you polarity as well as the pinouts is a pretty tall order. It probably could be done but it would require a microprocessor to supervise all the permutations of lead connections and then make a judgement as to which beta reading is the correct one. One of our readers might be interested in coming up with a suitable design which we could publish. Any takers?

We have published quite a few dual rail power supplies with single current limit over the years but all of those have been dual tracking types. In other words, both rails are varied by the one pot. Is that what you are suggesting or do you want independent control of both rails? We have not designed a power supply to meet this particular requirement.

Speed controller a source of EMI

The motor speed controller described in the November issue by John Clarke is very interesting and a great advance over the old elementary phase control, albeit at a definite increase in cost and complexity. It struck me immediately that it could be a stepping stone to the development of a variable frequency induction motor speed controller (VFC). But at the moment it brings up a number of other points:

(1) The width of those conductors looks rather small for 10 amps. If the average current is 10 amps then peak values are going to be much higher and I am more concerned since the board is fairly closely confined. I would have liked to have seen 6mm wide conductors for those tracks that are taking full rated current.

(2) I've never come across published specs or advertisements for IGBTs, so I wonder if you would consider doing a series on them, including and especially publishing manufacturers' application notes. Considering that they have already taken over the switching in 3-phase VFCs, it seems they are destined to replace bipolars and FETs in most high speed, high current mains voltage switching jobs.

(3) I don't want to knock this great design from John Clarke but I foresee problems with RFI emission. The LC filtering on the input may block most of it going back into the mains but it cannot stop radiation from the power cord out to the motor. Now it isn't just the 1.2kHz switching frequency that concerns us, it the dv/dt of the rise and fall times of the IGBT. This could generate the equivalent of frequencies in the Gigahertz range.

I wonder whether it would be possible to smooth the chopped waveform back to a variable amplitude half-wave sine curve before it leaves the controller case? In other words, reconstitute a smooth curve with some sort of LC filter. I'm no expert on filters but what about a low pass, hi stop filter with a corner just below the switching frequency at about 1kHz? That shouldn't require impossibly large values of L and C. Would it be effective? (P. D., Orange, NSW).

● While the maximum rating of the circuit is 10A, the peak currents will be no more than would be expected with a sinewave input; ie, 10A RMS is equivalent to 14A peak. When the circuit is set for lower than maximum speeds, the duty cycle of the circuit is reduced but this does not lead to higher peak currents, just lower average currents. At full speed, the IGBT is turned on all the time and so the currents are no higher than if the motor was connected directly to the mains supply.

Another point to consider is that most power tools do not pull their rated current for most of the time. They only do so at initial startup and when under severe loads. For most of the time, the current is considerably less.

We published an introductory article on IGBTs in the August 1996 issue. We can supply a back issue for $7.00 including postage.

You are correct in stating that interference will be radiated from the power cord to the motor. However, in this case, while it may be switching very rapidly, the interference produced is a function of the risetime of the current pulses and this very much depends on the motor's inductance, not the circuit switching speed. In fact, we have found in the past that SCR motor speed controllers cause virtually no interference at all as it is completely drowned out by the considerable interference generated by the motor's brushes and commutator.

appropriately increase the voltage of the supply capacitors, etc. Will the driver board semiconductors handle the increased supply voltages? Will this be OK or will I have to use an additional discrete power supply for the output stage transistors as these transistors can handle up to 250V?

Secondly, I would like to know if SILICON CHIP has previously released a separate LED digit (not LCD) temperature/thermometer display module readout so I may continuously monitor the temperature of the individual heatsinks on the amplifier modules. (L. D., Albury, NSW.

● It is true that we have not rated the amplifier for loads below 4Ω and we would not recommend it for use with say, 2Ω loads because of the likelihood of exceeding the safe area of operation (SOA) of the output transistors. However, the curved load lines on page 27 of the August 1997 issue demonstrate a nominal 4Ω loudspeaker with a DC resistance of 2.83Ω and an inductive reactance of 2.83Ω, (giving a total impedance of 4Ω). While not a "worst case" condition this is a fairly stringent load.

By contrast, most 4Ω speakers could be expected to have a DC resistance of about 3Ω and their impedance over the whole audio range could be expected to be well above 4Ω. Even those rare speakers that do have an impedance dip to around 2Ω or so would not necessarily represent a worse load than our above test condition.

According to your measurements, your paralleled speakers have a DC resistance of 3.6Ω. Therefore, unless there is a badly designed crossover network to be taken into account, it is not possible for your speakers to have a lower impedance – the DC resistance is the absolute minimum.

We do not recommend any modifications to increase the power output of this amplifier. It took many months of development before we were happy with the design as presented and any extension of the design would require careful evaluation and testing.

An 8-channel digital thermometer was featured in the January 1997 issue of SILICON CHIP.

Overload in the guitar mixer

I have just completed another 4-Channel Guitar Mixer Preamplifier, as published in the January 1992 issue of SILICON CHIP. The circuit works very well with most signal sources I have plugged into it, with good clarity and punch. However, the first problem I have is that when I plug my Sony compact disc player into any of the inputs, I get distortion on heavy sound passages.

Could this be due to the fact that a

lot of CD players exceed 2V RMS output instead of the 1V specified in this preamp circuit? Can I modify one of the inputs to suit a compact disc player as I plan to use it quite often? I also plan to dedicate channel 1 & 2 for guitar use only and channel 3 to keyboard.

The kit I purchased from Dick Smith Electronics and varies somewhat from your original design. Instead of all the inputs being 10kΩ impedance and 1V maximum signal input, they have printed a chart and left the inputs up to us to decide. They also specify resistors placed across the input socket.

My problem is that I have no idea what the best input signal and impedance is required for use with an electric guitar. If I plug my guitar into any of the inputs with the inputs set in your article (10kΩ @ 1V), I do not seem to have a lot of gain and the keyboard and CD player seem to climb all over the top of it even with the gain control for the guitar up full.

I was told that if I want the best out of my guitar, I need to change the input impedance to at least 250kΩ or even 1MΩ and that the input signal should be around 30mV to get the gain I need. I was also told the input should be "high Z". What does this mean? What is the ideal input impedance and signal level for an electric guitar to play lead or rhythm? (K. S., Morphett Vale, SA).

● The 2V output of a standard CD player is much too high for the input preamplifiers as they stand but this can be easily fixed by reducing the gain of the respective input. As they stand, the gain of each preamplifier is 19.3 and you would need to reduce that to below four to ensure that a CD player did not cause overload. To achieve this gain, for one input, change the 1.2kΩ resistor from pin 2 of IC1a to 7.5kΩ or 8.2kΩ and change the associated 22µF capacitor to 4.7µF.

As far as your guitar input is concerned, you may need a little more gain and this can be obtained by reducing the 1.2kΩ resistor to 680Ω. We would not recommend reducing it further than that.

The only reason to increase the input impedance of the preamplifier for guitars is if the upper treble response is being severely curtailed and we don't think that's likely. You may increase the input resistor to 47kΩ from 10kΩ if you wish but going above that is pointless.

Z is the symbol for impedance and "high Z" means high impedance. **SC**

Making mods to the high energy ignition

Several years ago I installed the High Energy Ignition kit (SILICON CHIP, May/June 1988) into my car. The unit has operated well, although I have found it to be very sensitive to supply voltage drops. On several occasions when I have had battery/alternator problems causing drops to below 12V, the unit has failed to operate, even though the car would still run with the unit bypassed.

Have you encountered this problem before? Could there be a problem with my circuit? Are there any circuit mods available to make the circuit more robust with supply variations?

Also, I was wondering if SILICON CHIP has ever developed a project or kit for a car exhaust gas oxygen (EGO) analyser that is suitable for cars running on leaded petrol. I have seen kits around elsewhere that are limited for use with unleaded petrol only – these sensors would be poisoned by lead. There are some of us folk who drive older cars who would like to make the effort to make them run at top efficiency with minimal emissions. If you have not had such a project in the past, may I suggest that you publish one in the magazine. (T. N., Waverley, NSW).

● The High Energy Ignition system should not be sensitive to battery voltage and in fact should work quite well down to 9V or below. The fact that yours is playing up suggests that one of the resistor values is higher than it should be or one of the transistors is below par. It is also possible that you have a cold solder joint or a bad supply or chassis connection.

The only other explanation for the system being voltage sensitive is that your spark plug gaps are much bigger than they should be, leading to a requirement for higher than usual spark voltage. We emphasise that, even if the battery can barely crank the engine, the ignition system should be able to start the car.

We do not know of an EGO sensor suitable for leaded petrol. Speed shops with dynos and exhaust gas analysers normally change the sensors each year because they become poisoned with lead. Your best approach may be to use an EGO device only for tuning instead of for continuous readings.

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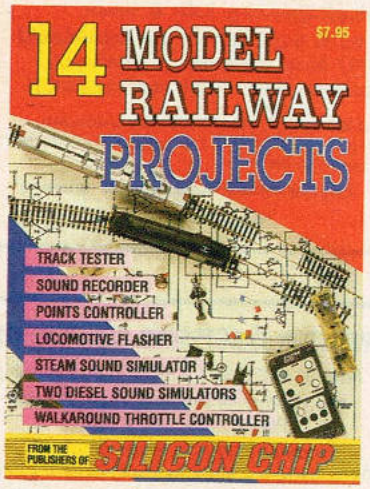

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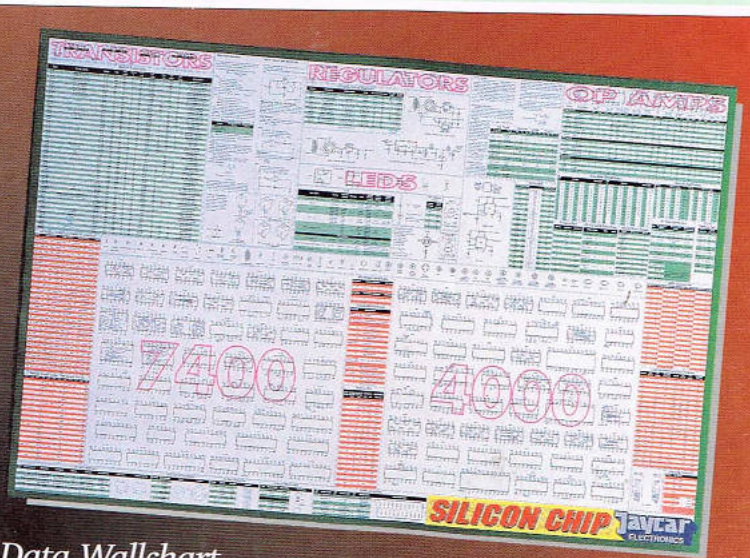

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